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The Institute of Vitreous Enamellers
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The New Manager

Anyone who cared to search the files of THE FOUNDRY TRADE JOURNAL with a view to ascertaining its policy for the training of foundry executives would find nothing very static. With the passage of time, the viewpoint has constantly changed with the advent of fresh requirements. A great factor (not generally realised) which influences the outlook of the ambitious youth is the wording of the requirements for foundry executives. Twenty years ago, advertisements for foundry executives stressed as essential the ability to calculate cupola mixtures from analyses. A few years later it was noticed that applicants should be able to institute a thorough metallurgical control. More recently still, emphasis has been placed on the need for a knowledge of costing, and many other attributes. Throughout this period there has been a tacit assumption that all applicants could make castings!

It was only natural that serious-minded young men should decide to equip themselves for such vacancies by studying metallurgy and costing, and, moreover—since mechanisation has been an important factor—applied mechanics. Now the time has come when directors of large foundry concerns are satisfied that they can obtain all the metallurgical and accounting help they require, but they say there are difficulties when seeking men who are really expert in the production of castings, and who have the necessary quality of leadership. In other words, there appears to be a recognition of the idea that the modern foundry manager should have full knowledge of the actual manufacturing methods for the production of castings whilst leaving the control of the metal and sand to a skilled colleague. This, of course, looks very well on paper, but only rarely in practice does it work out satisfactorily, as the foundryman has obviously some justification in asking, if he is not responsible for either the metal or sand (or other refractory material), how he can rightly accept the blame for wasters or any recognition for their comparative absence. Yet to acquire a profound experience of the making of large castings—and it is this phase which we have in mind at the moment—reinforced with a sound knowledge of metallurgy, is a task of such dimensions that it leaves little time to absorb the ancillary information essential for the proper conduct of a foundry.

The solution of the problem is obviously a compromise, the nature of which will vary from foundry to foundry. For foundries making very heavy castings, the manager should have been trained on the floor, and have sufficient knowledge of metallurgy to be able to practise its precepts, without being by any means a master of the subject. For light repetition work, and especially malleable ironfoundry practice, the metallurgist can acquire sufficient practical knowledge of moulding to assume full charge. In the former case the assistant would be the metallurgist, and in the latter a high-grade practical man. We could point to cases of an outstandingly successful character where foundries are operated under the joint control of a practical foundryman and a metallurgist, but in every instance they embrace temperaments which never seem to clash. Where such conditions can be instituted, excellent results are assured. A pre-requisite, however, is a true appreciation of a colleague's specialised knowledge.

There is no need for anxiety over the present alleged dearth of really practical men capable and willing to assume control. Just as for generations the moulder and patternmaker have had a working knowledge of each other's craft, so too in the future metallurgy will be grafted on to the foundryman's tree of knowledge. Grafting, however, is not an operation effected by nature, and a percentage of the youth of the industry must be given some insight into the principles of metallurgy. On the other hand, some of the young metallurgists in the appropriate type of foundry should have the opportunity of acquiring a practical knowledge of moulding and allied subjects. It is not by any means necessary to give such a training to all apprentices in this way, as it would result in creating "Jacks of All Trades"—a position which some employers say has already arisen. Only those youngsters showing special promise should receive training in the allied departments. It might be made a condition before promotion to the position of charge hand or a position on the senior section of the metallurgical staff. Again, in the case of University graduates, a condition of employment in th foundry could be usefully laid down as a yea. on the "floor" before a staff appointment.

As employment advertisements influence the study of the ambitious, those directorates seeking practical men as managers must not stress the importance of a knowledge of so many ancillary subjects, but state quite clearly that such help will be provided by competent assistants.

The Copper Situation

BY "ONLOOKER."

Of the four base metals traded on the London Metal Exchange, tin has had the reputation for extreme fluctuations; but copper is not far behind, and one has only to look back to the year 1937 to see what the price curve of this metal can achieve. Starting below £50, the standard quotation climbed to £77 10s. before the break came in the early days of March. Thereafter there was a steady decline until finally the market bottomed at £37 in November, a drop of £40 in eight months, which certainly sets consumers of the metal an awkward problem to solve.

Stability, so far as copper is concerned, has proved to be something of a Will-o'-the-wisp, although it has always been placed in the forefront of the producers' schemes of control, not always with conspicuous success. The present scheme is, however, working admirably in that respect, and throughout the whole of this year (and, indeed, over the past twelve months) there has been little to complain of on the score of price fluctuation, electro having kept within a pound or two of £50. What has not been quite so satisfactory from the point of view of those whose business compels them to use the London Metal Exchange for hedging operations is the widening of the spread between standard and electro, which went as far as £7 a couple of months ago and is still more than £6 on the basis of the cash price.

Refined Copper Supplies

It is probable that, as a result of the relative cheapness of standard copper, a moderate tonnage has been withdrawn from warehouse for consumption, but it is now something like twelve months since the differential between standard and electro stood at £4 10s. to £4 15s., and the comparative scarcity of prompt refined copper precludes the likelihood of an early return to normal conditions. Prior to the imposition of the American import duty on copper, a spread of £6 between standard and electro would have made it profitable to ship rough copper to the States for refining, but in present circumstances the metal would have to be refined in bond and reshipped, the double freight making the proposition out of the question. Nevertheless the position regarding supplies of refined copper outside the United States is that early metal is far from plentiful, and if the present rate of production, now scaled down to 95 per cent., is not raised, it would not be surprising to see our reserves of rough copper drawn upon for the purpose of refining.

In the States the situation is easier, but exports, especially to Japan, are heavy, and with June sales on the domestic market at 66,000 short tons and the tonnage for the first week in July at but little less, there cannot be any great surplus in the producers' hands.

It will be remembered that the American price came down from 11 cents to 10 cents in the middle of April, and there have been occasions since then when it has seemed as if even the lower level would have to be cut in an attempt to attract business. An excellent export demand has saved this, and the recent announcement that the French Government was negotiating for some 50,000 tons of copper gave an impetus to a modest upward movement which, at the time of writing, has enabled the U.S. producers to raise their selling limit to 10¼ cents, with the prospect of a possible 10½ cents to follow.

One large producer in the States is credited with an inclination to resist the upward movement; but the domestic buyer has had ample opportunity to buy at 10 cents, and did actually take a good deal at that level. Opinion in London inclines to the view that values of copper are not likely to advance very fast or very far.

Institute of Metals

GLASGOW AUTUMN MEETING

The Council of the Institute of Metals has issued the programme of the Annual Autumn Meeting of the Institute, to be held in Glasgow from September 5 to 8, 1939. Members will be welcomed at the conference headquarters in Glasgow—the Institution of Engineers and Shipbuilders—on the evening of Tuesday, September 5, by the Lord Provost of Glasgow, the Chairman of Governors of the Royal Technical College, and the President of the Glasgow Chamber of Commerce. After a short business meeting Mr. W. Murray Morrison, F.Inst.Met., will deliver the 17th Autumn Lecture on "Aluminium and Highland Water Power."

In the morning of Wednesday, September 6, the first technical session will be held, under the chairmanship of Dr. C. H. Desch, F.R.S., President of the Institute of Metals. Seven Papers will be presented for discussion.

After the morning meeting members will partake of luncheon by invitation of the Scottish Local Section, and will then proceed to visit the works of Messrs. John Brown & Company, Limited, Henry Wiggin & Company, Limited, and Albion Motors, Limited. In the evening there will be a Civic Reception at the City Chambers.

The concluding scientific session—held in the morning of Thursday, September 7—will be devoted to a general discussion on "Machinability." Following this meeting there will be an official luncheon at the Beresford Hotel. Afterwards members will leave for visits to the works of Glenfield & Kennedy, Limited, and Barr & Stroud, Limited. In the evening a dinner and dance will be arranged.

On the concluding day of the meeting, Friday, September 8, there will be an all-day excursion on the River Clyde. Detailed programmes of the conference may be obtained on application to Mr. G. Shaw Scott, M.Sc., F.C.I.S., Secretary, 4, Grosvenor Gardens, London, S.W.1.

Catalogues Received

Exhaust Fans. An extremely wide range of exhaust fans bearing the trade name "Genalex" is comprehensively dealt with in a 48-page catalogue just issued by the General Electric Company, Limited, of Magnet House, Kingsway, London, W.C.2. This publication is a veritable technical guide, containing as it does much valuable information upon the subject of ventilation. Technical data and tables are presented in an original and simplified form, enabling estimates to be made of fan performance under a variety of operating conditions, such as the evacuation of inflammable gases, hot and corrosive atmospheres, and so forth. This catalogue is essentially one of the "useful" type, and so has been perforated for hanging up or placing in a loose-leaf file. It is available to those readers who write to Magnet House.

Heat-Resisting Steels for the Enamelling Industry. A rather impressive four-page leaflet has been received from Hadfields, Limited, of East Hecla Works, Sheffield, dealing with "Era H.R." heat-resisting steels for use in the vitreous enamelling industry. We have used the word "impressive" because the leaflet refers to jobs much bigger than the usual perrets and supports. For instance, there is illustrated a complete enamelling muffle casing, which looks as though it would measure at least 15 ft. long, all carried out in heat-resisting steel. Moreover, there are pictures of quite large dampers and recuperators made in this material. The leaflet is available to our readers on writing to Sheffield.

Random Shots

This is the season of petty annoyances. "I'm sorry," says a sweet voice over the telephone, "but Mr. Serge Pantz is abroad and is not expected back until next week." The salesman, hopefully hopping round the country, vainly thrusts his card into unfamiliar hands. "Sorry, sir, the chief's away. Daren't do anything till he comes back," greets him at every place of call. The secretary writes appealing letters for a reply to "ours of the umpteenth inst.," only to come to a reluctant conclusion that perhaps, after all, Mr. King Pin might be on holiday and is not merely slack. Old Bill, the pattern store keeper, the only man who can just put his finger on the pattern needed at the moment, has gone off to Blackpool with the missus and kids. How the blazes can anyone else be expected to fathom a system known only to Old Bill himself?

* * *

But revenge is sweet, and at last there comes one's own chance to turn a cold shoulder to the office and a deaf ear to daily demands, to wash off the grime of the works and really *take a holiday*.

* * *

To some this means basking in the glitter and glamour of a smart hotel at a smarter seaside resort. Choice of hotel to them must be a matter of gilt and grandeur. Others find rest in the quiet country inn, and to them choice is often a matter of antiquity and amiability, but there is one great frequenter of country inns who declares that he chooses his pub by asking to see the mustard pot and casting his vote according to its condition! To anyone who perforce spends a good many of his precious evenings dining in a stiff shirt at public dinners, a holiday abroad, especially in France, offers a delightful prospect. What relief he experiences when the waiter, instead of hissing in his ear "Red or white, sir?" recommends and discusses the qualities of the best wines *de la région*. What pleasure is to be derived from a wine list long and strange, having spent the greater part of the year amongst wines that are usually put into two classes only, table wines and under-the-table wines!

* * *

Apropos of drinks, there is a good story of the colonel who, winning a cask of doubtful beer, decided to serve it out to the troops instead of risking it in the officers' mess. The boys lapped it up readily, and next day the colonel asked what the verdict was. "It was just right, sir," said the sergeant-major. "If it had been any better we wouldn't have got it, and if it had been any worse we couldn't have drunk it."

* * *

A task set at a school examination was to draw a map of Europe, and the brightest boy of the class failed to do it. He wrote across the page, "Sorry I cannot answer this question, as I didn't listen-in to the news last night."

* * *

An intriguing name for a boat seen on a fisherman's craft at a small fishing village: "For God's sake let me sleep."

* * *

An equally intriguing name was given to the house built not long ago for Dr. A. B. Everest, behind which lies a story. Much discussion had taken place over the choice of a suitable name, and the onus of a final choice was at last left to Mrs. Everest, who hit upon the idea of calling it "Camelot," which was, of course, Arthur's Seat!

"MARKSMAN."

New Works of Keith Blackman, Limited

A CENTURY OF PROGRESSIVE DEVELOPMENT

It seems almost superfluous to say of an industrial concern with over a century of successful trading behind it, that the period has been one of progressive activity. During recent years, we have seen, with very real regret, so many old-established engineering concerns go out of existence and we do not think there is much difficulty in finding an explanation. When the managements persist in the production of units of plant, which, at the time of their introduction were representative of the last word, but which advances in technique have rendered hopelessly out of date, unsatisfactory results are inevitable. Happily we still have a number of manufacturing engineers with the traditions of a century behind them who continue to hold a foremost place in our industrial undertakings. Of these firms, Keith Blackman, Limited, are a striking example, and it is worthy of note that the responsible conduct of the business has extended through four generations, the present chairman and managing director of the company being the great-grandson of the founder, Mr. George Keith, who, in 1823, laid the foundations of the present company by the establishment of a small engineering works in High Street, Arbroath, Scotland. This business ultimately passed into the hands of the late Ex-Provost George Keith, and while the business prospered under his management, developments had not been outstanding. In the meantime his eldest son, Mr. James Keith, was gaining experience in America and Canada, and the conduct of the business was handed over to him in 1868.

Mr. James Keith was a clever engineer with very definite inventive ability, and during his conduct of the business was responsible for the evolution of numerous hydraulic, heating and ventilating and other appliances; amongst other things, he was the originator of the modern type of sectional boiler for hot-water heating.

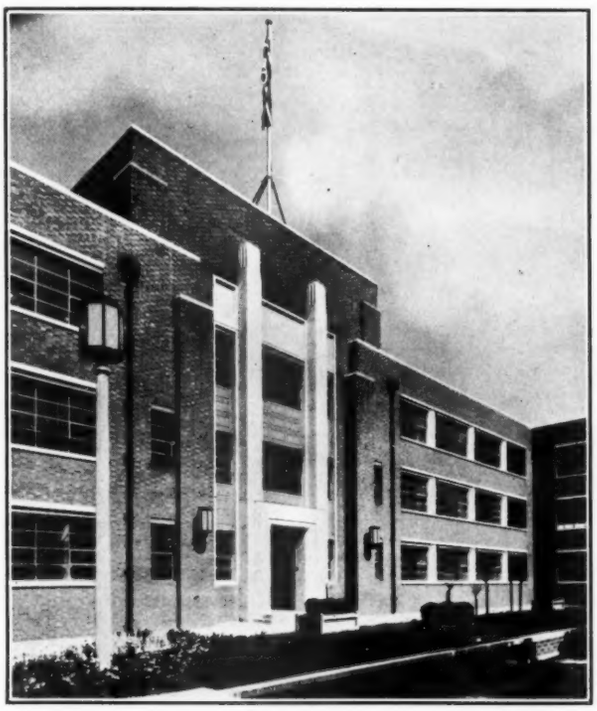
We must now consider the Blackman Air Propeller Ventilating Company, Limited, which was formed in 1883, with works at Holloway. This company was the pioneer of the propeller type of fan, which was successful from its inception, and to the manufacture of which the activities of the company were, at that time, exclusively devoted. In 1900 the business of James Keith was amalgamated with the company under the style of James Keith & Blackman, Limited.

Mr. George Keith, the present chairman and managing director of the company, developed the system of high-pressure gas lighting which met with immediate success. At the same time, the company were developing in other directions, adding to their activities the construction of high-pressure blowers, gas boosters, etc. The most important development was, however, the invention of the "Keith" centrifugal fan, which is now in world-wide service.

Considerable extensions were made to the foundry at Arbroath in 1901, whilst in 1912 the building of the Lordburn Works at Arbroath was commenced, the shops covering some 2½ acres. At the same time considerable extensions were made to the London Works at Holloway.

The field of usefulness of the fan has, of course, extended very appreciably during recent years. New applications are constantly presenting themselves, including powdered-fuel firing, dust collection, blowing, and more recently the problem of ventilating bomb-proof shelters. Obviously the fan and its fitments must be designed for the definite duty. In meeting each new demand Keith Blackman have always been amongst the pioneers. It is not surprising, therefore, that the new demands could only be met by further extensions to works and plant.

In 1926 a three-floor building was erected at Holloway; three years later additions were made to the Arbroath Works to the extent of 1½ acres. Ten years later further extensions were made to Arbroath by the erection and equipment of an iron foundry for the production of light machine-moulded castings. Extensions at the Holloway Works had already been carried to their economic limits, and when additional space had to be found in order to keep pace with the increasing demand, it was realised that any attempt to increase the output of the Holloway Works must result in congestion, which would mean uncomfortable working conditions, in other words, would not be conducive to efficiency. With that same enterprise which has characterised the management during the past 116 years, it was determined to select a suitable site and erect a new works where liberal provision could be made for future extensions.



VIEW OF THE MAIN ENTRANCE.

THE NEW WORKS

The company acquired a site in Mill Mead Road, Tottenham, London. Not only is the site eminently suitable for a works of this character, but the directors felt that in such a locality the employees would be working under healthier conditions and their social possibilities would be greater than were the works located in a purely manufacturing area. The works, which are in close proximity to Tottenham railway station and within easy reach of the city, cover an area of 10½ acres.

The approach to works and offices is through a gateway entrance by way of broad concrete roads flanked with stone curbing and grass verges; flower borders are also laid out. The offices occupy a block of buildings of very imposing elevation which conveys an unmistakable impression of stability. The main works are housed in two blocks of buildings which are placed in parallel with a broad road between them. On the one side is the sheet-metal department and on the other the fitting and auxiliary shops. A considerable tonnage of sheets, in fact the major portion, is delivered direct to the works by road, and the provision of the central road enables them to be discharged at the most convenient point for their passage through the works.

The opposite side of the fitting and auxiliary shops is bounded by railway sidings which are served by two cranes of 10 tons and 5 tons respectively.

Sheet Metal Department

The sheet metal department is housed in a building 800 ft. by 200 ft., the bays running at right angles to the length and the roofs provided with north lighting, while the floors throughout are laid with reinforced concrete. The sheet store is at the road side of and practically in the centre of the length of the building. Stocks are carried on steel racks and immediately beyond these, on the shop side, are the shears and presses. Shears are installed capable of cutting sheets up to 8 ft. in length. There are 14 presses ranging from 6 to 75 tons; some few are arranged for group driving, others are independently driven. A recent installation is a Pels bending press of 100 tons capacity. The duct shop is housed on the one side of the press and shear department. Each individual production of the duct shop might be regarded as a special. Beyond auxiliary shears and the like there are few machines, hand work being almost exclusive. It is in this shop also that the cyclones are constructed, a production in which a considerable business has been built up and it may be noted that cyclones up to 12 ft. 6 in. dia. have been built.

There are certain classes of the smaller fans which might be called machine productions, as they are fabricated throughout by means of spot welding, for which work there is a battery of 30 spot-welding machines. A portion of the shop is laid off for repetition work such as unit heaters, filters, etc. A department is also laid off for the building of special fans, which calls for the employment of highly skilled men. On the opposite side of the press department the casings for the fans, etc., are fabricated or riveted as the case may be.

Balancing Department and Test House

In the balancing department are installed four dynamic balancing machines on which can be balanced multivane fan runners, armatures, and rotors from 1 oz. up to 2 tons in weight. The dynamic machine is much superior to the more old-fashioned static balance, because it gives a perfect running balance and there is no vibration; hence there is less wear and tear on the bearings, giving longer life. There are also installed six balancing tables for balancing streamline runners of any size from 6 in. up to 96 in. dia. Shut off from the main building is a well-equipped experimental department, the main duty being efficiency testing of new designs as also the testing of routine productions when desirable.

The test house is laid out on the most modern lines. Metrovick panels are installed throughout. In this house all blowers, boosters, turbos, and motor-driven fans are tested, the liberal nature of the test-plate provision allowing no fewer than 200 machines to be tested simultaneously;

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actually about 1,300 machines are tested during the week. Where the fans are for service in public buildings and the like, quiet running is a factor of vital importance, and rooms are set apart with sound-proof walls where tests for silent running are carried out.

Miscellaneous Departments

The spray-painting shop, as one would expect, is very efficiently ventilated. There is a separate department in which cellulose-paint spraying is done, the fumes being exhausted by Blackman streamline fans, through wood-wool filters. The incoming air is warmed when required by copper gilled-tube radiators.

The winding shop connected with the motor department has the usual equipment for light motors, whilst a bench is laid off in the fitting shop for winding heavy machines. Two methods of impregnation are in service, the hot dip and bake method and the ordinary vacuum impregnation. There are eight electrically heated ovens, heated by Keith Blackman electrically driven heater units. The heating is thermostatically controlled, permanent records of temperatures being kept by recorders, and after the articles to be impregnated go in for final baking, the ovens are automatically controlled by synchronous time clocks.

The fitting shop has the usual equipment of up-to-date tools, which for the most part are group driven. In the smiths' shop, in addition to the usual hearths, there are a number of forming tables for the production of special shapes and sections, the hot bars being bent round formers. These tables are served by a special furnace, which is gas fired. Other equipment includes a Hancock oxy-acetylene cutting machine, oxy-acetylene and electric-welding plants, etc.

The lighting and heating department, in which the work carried out is more or less standardised, does not call for any special description; at the same time, it may be mentioned that all unit heaters are subject to a hydraulic test of 500 lbs. per sq. in. and a steam test at 80-lbs. pressure per sq. in. Steam for this test is raised in a coke-fired vertical boiler and installed in the same house are two coal-fired horizontal boilers fitted with automatic stokers, which serve the heating system for the works.

The power house, with its tiled floor and glazed-brick walls and the neatly painted generating sets, has a distinctly central station appearance. The power plant consists of six Diesel engines, four of which, having six cylinders, develop 165 b.h.p., while there are two three-cylinder units, each rated at 82 b.h.p. Each engine is directly coupled to an alternator operating at 50 cycles, 380/500 volts, with an exciter in tandem. The generators have outputs of 110 kw. and 54 kw. respectively. This station meets the demands for electricity for actual works production requirements and the fluctuating demand for current for testing large blowers, boosters, turbos and motor-driven fans.

Direct and alternating current is needed, the latter of single phase, two-phase and three-phase, with frequencies varying from 25 to 100 and voltages from 50 to 500 direct current. The converter for the spot-welding machines is installed in the shop. One side of the power house is bounded by the railway so that fuel supplies can be taken from the rail tank wagons as well as road tank wagons.

Both gas and electricity are used for lighting the works, "Keith" high-pressure gas lamps for the general lighting, and electric lamps for individual lighting of machines. Outside lighting is provided by "Keith" high-pressure gas lamps suspended from bracket arms on the walls and "Keith Magnalux" low-pressure gas lamps with "Keith" raising and lowering gear from columns and bracket arms.

There is a very well-appointed canteen capable of providing for 650 persons at one sitting. Two types of services are provided, a waitress service for the executive staff and a cafeteria service for the work people. Adjoining the main canteen is a directors' dining room.

Office Heating and Ventilation

Designed by specialists, the heating and ventilation systems call for some consideration. For the office block this consists of a balanced system of inlet and exhaust providing six air changes per hour in the summer and four in the winter, exposure losses being dealt with by direct radiator warming. For winter conditions the system is designed to maintain a temperature of 65 deg. throughout the offices with an outside temperature of 30 deg. F.

The heating system is an accelerated hot-water type, utilising cast sectional boilers fed by underfeed stokers. The air for ventilation is drawn by "Keith" multivane fans of the latest pattern, into an air-treatment plant through "KB" "Throw-away" pad filters, a "KB" copper gilled pre-heater, "KB" spray type double bank washer chamber and final heater—also of the "KB" copper gilled type. The plant is automatically controlled, for winter conditions only, by means of thermostats and magnetic solenoid valves, so arranged as to control the dew point and final conditions of the air entering the building.

The main heating system is also controlled by means of a master thermostat in the building which operates magnetic valves at the boilers, and all the private offices and the boardroom have individual thermostatic control with magnetic valves which can be set to the individual requirements of the occupier. The fans discharge the air into ducts formed in the building construction entering the various rooms through grills at high level. The exhaust ventilation generally throughout the offices is by means of ducts formed over the central corridors of the building.

Heating and Ventilation of the Main Works

The heating of the works is done entirely by means of "KB" Unit heaters, using hot water as the heating medium, and each unit is fitted with an adjustable nozzle to ensure the air being discharged to reach the working level. The units are slung from the steel framework of the saw-tooth roof, having fresh air and recirculating inlet ducts fitted, and are capable of giving two air changes per hour.

As in the case of the office block, the system is an accelerated hot-water type, utilising Super Economic boilers with automatic stokers, the stoker hoppers being fed with fuel from an overhead coal bunker constructed in reinforced concrete and having a capacity of 250 tons, the feed from the storage to the boiler hoppers being by gravity. A conveyor is fitted to transport the coal from railway trucks and distribute the coal along the length of the bunker.

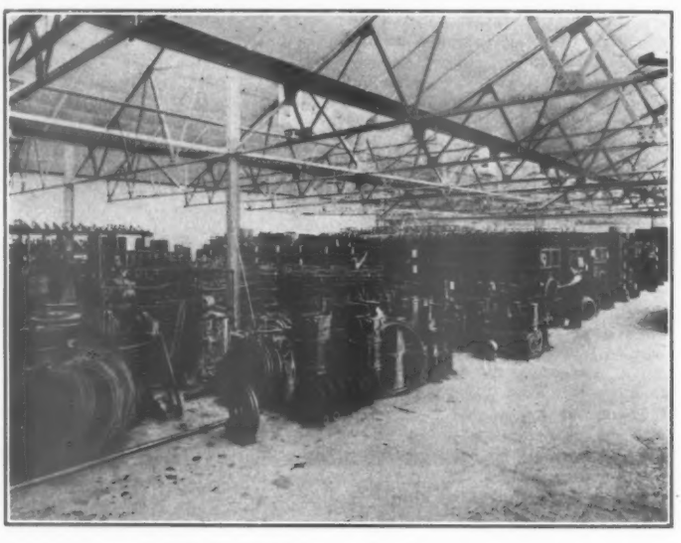
The power house is provided separately with an air-inlet plant, consisting of four "Blackman" streamline fans, the inlet side of each being fitted with "Keith Blackman" "W" type oil-film filters and copper gilled heaters for tempering the air in winter. This inlet equipment is capable of providing up to 15 changes of air per hour in this chamber. Similar fans are situated in the outside external wall to exhaust air at the same rate.

Arrangements of air inlet and exhaust for the electrical test shop are similar to those provided for the boiler house to ensure that the air entering shall not be dust-laden, the filters in this instance being of the company's standard vertical fixing oil-film type.

The lavatories throughout the works are provided with hot water by means of electrically heated storage cylinders, a separate storage cylinder being situated in each of the six lavatories in the works.

The main restaurant is supplied with air at the rate of four changes in the winter and six changes in the summer, the air being filtered and warmed. There are two 4-section "KB" gas-fired boilers, the total capacity of which is 320 galls. per hr. at 140 deg. F., providing all the hot water for the canteen.

HEAVY MACHINE SHOP.



VIEW IN THE CASTINGS STORE.

Laws Governing Cupola Operation*

By Dr.-Ing. MASSIMO BARIGOZZI†

[*Presented on behalf of the Federazione Nazionale Fascista degli Industriali Meccanici*]

The general equation for the cupola, which is attributed to Falk, according to what has been recently stated by Jungbluth,[1 2 3 4] is expressed as follows in the author's notation:

$$\frac{QaK}{3{,}600} = \frac{V}{M} \quad .. \quad .. \quad .. \quad (1)$$

where Q is the hourly output of the furnace in quintals (100 kg.) of iron,
K the percentage of coke relative to the iron,
a the carbon content of the coke,
V the blast volume in cubic metres per second.

As a percentage K is to be taken as meaning the *total quantity of coke in kilograms which is burnt in melting 100 kilograms of iron*, of which quantity the *charge percentage* is only a part, even if the greater part.

In fact, there is burnt with the charge coke a part of the "bed" coke, which may or may not be replenished during the melting operation by extra charges of coke, so that in order to determine K it is necessary to obtain the difference between the total coke introduced (charge coke, extra coke, bed coke) and that recovered in dropping the bottom (a deduction being made for the ignition coke, *i.e.*, the coke burnt in front of the tuyeres), or what amounts to the same thing, it is necessary to add to the charge percentage the amount of bed coke and total extra coke corresponding to each 100 kilograms of iron.

Since, as a rough average, this increase in the charge percentage is approximately 15 per cent. it follows that when K is put equal to 10, a charge percentage of 8.5 ÷ 8.7 per cent. is actually considered; a charge percentage of 10 per cent. produces a total percentage of 11.5, and so forth.

This being clear, it may be added that when in what follows the height of the *combustion layer* is calculated, this will not be limited to that of the charge coke, but will also include the portion of the bed coke participating in the combustion.

The significance of M is clear if it is borne in mind that the first member $\frac{Q \alpha K}{3{,}600}$ is none other than the quantity of carbon burnt per second, and if X″ is the corresponding quantity of coke, it is equal to $\alpha X''$. Hence $M = \frac{V}{\alpha X''}$ that is, M is the specific blast volume per kilogram of carbon burnt.

M is not constant, but varies according to a law which is to be determined. Its value is obviously strictly connected with the performance index *i* expressed as the ratio between the quantity of CO_2 contained in 1 cub. m. of the waste gases and the sum of $CO_2 + CO$.

This is the general position of the problem of the cupola which leads to equations and diagrams where the variables M or *i* and the comparisons in general between the various magnitudes are established as functions of $\alpha X''$, that is of the quantity of carbon burnt in unit time, or of αK, that is the quantity of carbon burnt per 100 kilograms of iron.

It is true that this is the only method of attaining results which are strictly scientific and of general application.

Here, however, reference is made to the coke employed in cupolas in Italy where, *on an average*, $\alpha = 0.86$, and the calculations are given on the basis of this *mean value*, that is referring to coke rather than to carbon, so that the diagrams obtained are not strictly accurate, but are a sufficient guide for the operation or design of cupolas.

The series of diagrams to be considered as general, that is referred to the carbon burnt, will be established after completion of the series of tests of really scientific character on cupolas actually in operation, which was decided on by the Federazione Meccanici—Foundry Group, and for which a sum of 100,000 lire has been provided. Referring, therefore, to coke having 0.86 carbon and not to pure carbon, equation (1) becomes:—

$$\frac{QK}{3{,}600} = \frac{V}{m} \quad \text{and} \quad \frac{QK}{3{,}600} = X''$$

where *m* is the specific blast volume per kilogram *of coke*.

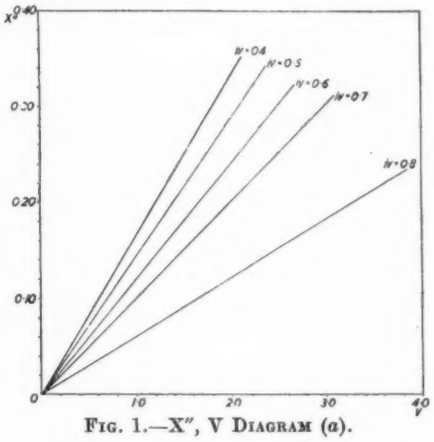


FIG. 1.—X″, V DIAGRAM (*a*).

If the theoretical amount of air suffices for combustion, then for a coke containing 0.86 of carbon, like the ordinary metallurgical coke employed in Italian foundry practice, the theoretical blast volume at 18 deg. C. would be $V_t = 4.08\ (1 + i)\ X''$... (2). Thus, in an X″, V diagram showing the relationship between the coke burnt and the blast, there would be for each performance index *i* a straight line starting from the origin:—

$$X'' = \frac{1}{4.08\ (1 + i)}\ V \quad .. \quad .. \quad (3)$$

The blast, however, is always in excess and it is found that up to a certain limit at least, the excess must be increased in order to obtain better performance indices.

Tests carried out in Italy on cupolas with a coke having $\alpha = 0.86$ and normal reactivity show the following:—Referring to the square metre of furnace, for each value of X″ or V, the performance index is 0.4 when *m* is equal to about 6.50, a figure higher than the theoretical blast, which would be 5.71. For $i = 0.7$, $m = 10$ and for $i = 0.8$, $m = 12$.

The values are recorded in Table I.

In a Paper read at the Warsaw Congress[5] last year, the present writer, in the absence of analyses of the gases, made use of a hypothesis in order to establish graphically in a tentative manner the position of the straight line $X'' = \frac{1}{m} V$ in the X″, V diagram. A certain number of analyses have now shown that the positions are sufficiently near the true ones.

Further critical study of the measurements of the blast will presumably shift them towards the left, that is to say, towards lower values.

Accepting the determinations as they stand for the present, the X″, V diagram given in Fig. 1 shows the straight lines of the *performance indices*, the general equation of which would be $X'' = \frac{1}{m} V$. Fig. 2 shows the relationship between *m* and *i*; employing the analytical form, it will be seen that it can be written:—

$$m = \frac{4.08}{1 - i^{1.67}} \quad .. \quad .. \quad (4)$$

or

$$m = 2.34 \frac{2 - i}{1 - i} - 0.1 \quad .. \quad .. \quad (5)$$

which is a more convenient formula, sufficiently approximate in the only range under consideration, *viz.*, between $i = 0.4$ and 1, since for values below 0.4 it is defective.

The relationship between the variables X″, V and *i* with *m* would then be known, that is to say: Given X″ (the coke consumed) and the blast, the value of *i* is ascertained without the necessity of analysing the gases.

Given X″ and the analysis of the gases, the blast is obtained. The knowledge of the laws governing the cupola operation cannot be said to be complete, however, without a knowledge of the manner in which *m* (or *i*) depends upon the operation variables.

Jungbluth has given a formula for determining the index which he calls η_c and which is a hundred times greater than our *i* ($\eta_c = 100\ i$), as a function of K, after having expressed *m* as a function of η_c, on the basis, however, of the theoretical blast, which is not in accordance with reality.

Although the blast, as measured by the apparatus, and eliminating the leakage from the mains and making the corrections due to the atmospheric conditions, particularly the temperature, is greater than reality, and Leopold Schmid[6] records having frequently found that the real blast is only 0.80 of that given by the reading, yet by making such corrections, it is always found to be considerably in excess of the theoretical blast of each particular combustion, such excess being from 20 to 50 per cent. or more, and which commands acceptance, despite the very low values for the free oxygen in the analysis of the waste gases.[7]

The law according to which *m* varies with *i* is therefore not that of the theoretical blast, as

TABLE I.—*Data Obtained and Calculated for Thirteen Cupolas.*

No.	D. Mm.	A. Min.″	X″. Kg.-min.″	V. m³.-min.″	*m*.	*i*.	Γ.	Q.	S.	K.
86	1,300	1.327	0.195	1.81	8.26	0.61	753	67.82	0.175	10.4
81	1,000	0.785	0.222	1.71	7.71	0.66	636	57.32	0.198	14.0
20	600	0.285	0.188	2.03	7.91	0.57	880	68.42	0.195	9.9
9	500	0.198	0.206	2.92	10.05	0.63	757	75.75	0.168	9.9
72	900	0.636	0.243	3.14	9.60	0.57	786	78.61	0.195	11.16
65	850	0.567	0.077	1.58	18.00	0.92	617	35.27	0.109	7.94
8	500	0.198	0.166	2.07	12.31	0.78	757	75.75	0.134	7.9
66	850	0.567	0.169	2.20	12.85	0.92	705	88.18	0.109	6.9
23	600	0.285	0.169	2.45	12.72	0.68	880	77.19	0.156	7.9
83	1,200	1.131	0.194	2.21	11.25	0.67	885	88.41	0.157	7.9
37	700	0.390	0.176	2.35	12.10	0.75	615	58.97	0.148	10.8
71	900	0.636	0.233	3.14	10.74	0.67	786	94.33	0.157	8.9
56	800	0.503	0.152	2.48	16.08	0.84	796	79.50	0.123	6.9

* Paper presented to the International Foundry Congress held in London and organised by the Institute of British Foundrymen.
† Secretary of the Foundry Group of the Federazione Industriali Meccanici, Milan (Italy).

stated above, but another, namely equation (4) or for practical purposes equation (5).

Furthermore, it should be observed that the formula proposed by Jungbluth

$$\eta_v = \frac{386.5}{\frac{K \cdot k}{100}} + 15 \quad \text{where } \eta_v = \frac{CO_2}{CO_2 + CO} \cdot 100$$

and which rendered in the author's notation for $k = 0.86$ would become:—

$$i = \frac{4.49}{K} + 0.15$$

is in each case applicable only to the cupola operation in which the charge of iron is always

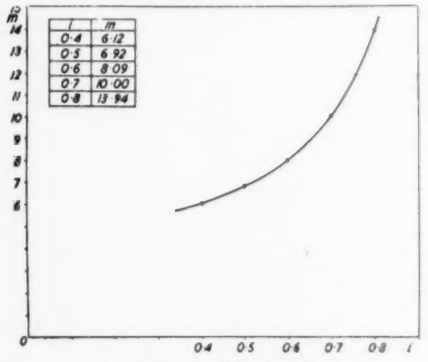


FIG. 2.—m, i DIAGRAM.

full (on the basis of 900 kg. of iron per square metre and coke 72 kilograms, if K = 8, that is, m is 0.160 of the layer) and K varies with the increase in the charge of coke.

The influence of the size of the pieces, recently studied by J. Buzek and N. Czyzewski,[8] will be disregarded.

The author has found, however, by examining more than 100 furnaces in Italy, that very frequently the charge per square metre of furnace drops to 800, 700, 600 and even 400 kgs. Under such conditions even a moderate charge of coke corresponds to a high percentage. If in the example given, against 72 kgs. of coke, there are not 900 but 600 kgs. of iron, the percentage of 8 becomes 12, and if the charge was reduced to 450, it would attain 16 per cent.

Under such conditions it can no longer be said that i will be a function of K. This, however, will be discussed further below.

Thus it will be seen for the above working conditions, with variable K and with a constant charge of iron, up to what point the laws recently enumerated by Jungbluth are not in contradiction with the indications of the X″, V diagram, and at what point the divergence commences. In the first place

$$m = \frac{4.45\,(100 + \eta_v)}{100}$$

which interpreted is expressed as

$$m = 4.45\,(1 + i)$$

Therefore, whereas according to Jungbluth

$$m = 4.45\left(1.15 + \frac{4.49}{K}\right)$$

according to the author's investigations

$$m = 2.34\,\frac{2 - \left(\frac{4.49}{K} + 0.15\right)}{1 - \left(\frac{4.49}{K} + 0.15\right)} - 0.1$$

According to Jungbluth, the difference between the values of m for varying values of K are less than those personally calculated. For example, for K = 10, m according to Jungbluth is 7.14, as against the author's 8.09. For K = 8, m according to Jungbluth is 7.65, whilst in the author's case it becomes equal to 10.

Jungbluth's diagram, however, is perfectly compatible with the author's. Thus, according to the former, in the X″, V diagram, the straight lines starting from the origin each represent one i and hence one K, and merely the slope of these straight lines differs in the representations given by him and the author (Fig. 1).

The same also applies to Jungbluth's Q, V diagram (charge, blast).

As $Q = \frac{X''}{K} 3{,}600$, there is at all events $Q = f(K, V)$, namely, an infinite number of straight lines, starting from the origin, one for each value of K. In this method of considering the subject, only the diagrams relating to Q K V T, showing the increase of T with K are compatible.

For the general case in which K varies in any manner, either on account of variation in the charge of iron or variation in that of coke, it can no longer be said that $i = f(K)$.

Various considerations regarding the combus-

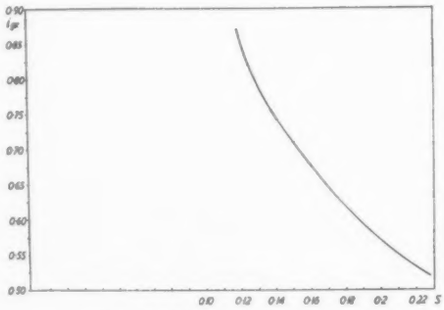


FIG. 3.—$i_g S$ DIAGRAM (b).

tion lead one to believe that the preponderant influence will be that of the layer S, and another, much less important, is due to the whole of the charge of iron. $K = \frac{C.100,}{\Gamma}$ where Γ is this charge and C is the charge of coke, and assuming a specific gravity of the coke of 450 kgs. per cubic metre, it gives $C = 450\ S$ per square metre of furnace, where S is the height in metres of the layer of coke of the charge, whence $K = \frac{45{,}000\ S.}{\Gamma}$

If, however, an i, S diagram (Fig. 3) is examined, there are no distinct i, S curves each corresponding to a Γ, as one would be led to believe on the assumption of $i = f(S, \Gamma)$. It is found, however, that for Γ less than 600 kgs., there will probably be such curves, while for Γ between 600 and 900 kgs., the

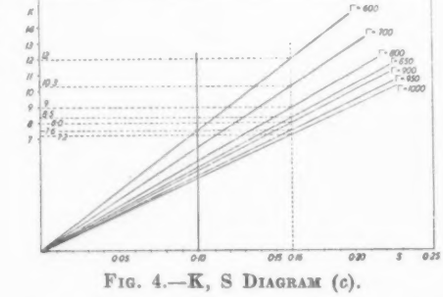


FIG. 4.—K, S DIAGRAM (c).

points lie in such a manner that it is possible to regard a single i, S curve (diagram of Fig. 3) as a plausible representation.

However, this curve (diagram b of Fig. 3) has an equation sufficiently close to $i = \frac{0.085}{S} + 0.15$.

It is possible to see in Jungbluth's curve $i = \frac{4.49}{K} + 0.15$ a special case of the former, namely the case relative to $\Gamma = 900$.

In fact, in such a case $K = 45{,}000\,\frac{S}{900} = 50\ S$ and by substituting this value in Jungbluth's equation that of the author is obtained. He therefore assumes this curve to be a general expression, with the remark that Jungbluth's observations permit this.

The author thus conceives a K, S diagram (Fig. 4). As $K = 45{,}000\,\frac{S}{\Gamma}$, there is a group of straight lines starting from the origin, one for each value of Γ. Finally, a Q, X″ diagram is formed (Fig. 5).

As $Q = \frac{3{,}600}{K} X''$, there is also a group of straight lines, one for each value of K.

Conclusions

In general, between the limits considered, the laws governing the operation of the cupola may

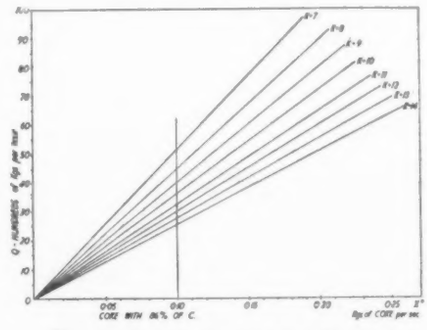


FIG. 5.—Q, X″ DIAGRAM PER SQUARE METRE OF FURNACE (d).

be represented for a given coke by four extremely simple diagrams:—

(a) X″, V which gives the straight lines of the *indices* i.

(b) i, S representing the curve of the variations of the index in general. That of Jungbluth is for a particular case.

(c) K, S representing the variation of K with S and with Γ.

(d) Q, X″ finally representing the variations of Q with X″ and with K.

Taking the coke of $a = 0.86$, these diagrams assume a mean value for Italian cupolas and thus lend themselves to the solution of the various problems of the cupola with a sufficiently close degree of approximation. These are problems concerning the rate of working of a furnace or affecting the design of a furnace yet to be constructed.

For example, if a furnace is to be taken over, X″, S, K and Q are known. From (b) knowing S there is available i, and hence V is found in (a). Diagrams (c) and (d) are not required as their data are known. Thus, without measuring the blast or analysing the gases, the performance index and the blast are known.

If it is a matter of designing a furnace, the data taken as basis are more often Q and K, it being necessary to find the other variables. It will be expedient to determine X″ from (d) and (c) and then to fix the value of S (and hence a value of Γ or *vice versa*). S being fixed, one obtains i from (b) and hence V is found in (a).

It is considered that when the figures and the positions of the lines have been confirmed, it will be very useful for the foundryman to be acquainted with these diagrams and to endeavour to make use of them for bringing into play the variables of the cupola in a manner more in agreement with industrial requirements.

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Radiography in Iron and Steel Founding

By F. W. ROWE, B.Sc.

(*Concluded from page 29.*)

Experience is prerequisite for the radiographer if a casting is to be adequately inspected, for he must be able to forecast where cracks, cavities, porosity or inclusions are likely to occur, and to expose his film accordingly. On certain jobs visual inspection may be used as a preliminary. Since radiography is expensive, the number of radiographs made per casting must be kept to a minimum. Experience is also necessary in interpreting the exograph when developed.

Using modern plant, the manipulation is very simple and foolproof. Exposures in the region of 20 to 30 mins. are usual when radiographing 4 to 4½ in. of steel. After exposure, the film is developed, fixed and dried, and usually inspected in the negative. By using negatives, rather than making positive prints, the maximum definition of the method is obtained, since the negative may be viewed by transmitted light and small local changes in density seen.

Using film packed in cassettes as described earlier, the sensitivity of the method is, in general, such that a change in thickness of 2 per cent. is detectable by eye on the film, that is, a cavity 0.08 in. deep in a 4-in. thickness of steel could be seen.

Radiography with Gamma-Rays

The principle of radiography with gamma-rays is precisely the same as with X-rays, except that the electrical source of X-rays is now replaced by a small quantity of radio-active substance. The substance chiefly used is radium sulphate, which has a longer life and is more permanent in nature than the alternative Radon, a gas otherwise known as radium emanation. Although it is possible to approach nearer to the ideal point source using Radon, difficulties are encountered, because the emanation has a half-life of only 3.85 days, which necessitates complicated adjustments to allow for the decreasing intensity during exposure. Radium salt, however, although more bulky, is to be preferred, since, even during the longest exposures, it is unnecessary to allow for any changes in the quantity of radiation.

The method is very much simpler than that involved in the use of X-rays. The film is placed behind the object and the radium placed in position at a definite distance from the film, and left there for the appropriate exposure time. Unlike X-rays, one is hardly troubled at all by scattering when using gamma-rays, as the scattered gamma-rays are almost entirely absorbed by the material of the casting. Thus, gammagraphs are particularly suitable for objects of irregular shape which, in exographs, would show extensive blurring and over-exposure under the thinner parts. Also, while the limit on X-rays at present appears to be about 4½ in. of steel, gamma-rays have been used for thicknesses as great as 10 or 11 in. of steel.

The slight absorption which is responsible for the great penetration of gamma-rays becomes a disadvantage when the rays reach the film, for the absorption and consequent reaction in the film itself become correspondingly less. In order to offset this effect, lead-foil intensifying screens are placed in contact with either side of the film, and these, when struck by gamma-rays, emit secondary electrons which have a greater effect on the film than the rays themselves. It is also common practice to use two films together, arranged lead-film-lead-film-lead. A double record is then obtained and faint marks the more easily interpreted. Pullen ("Engineering Radiography") gives a comparison between gamma- and X-ray exposures. The Research Department, Woolwich, at the time of his comparison, was using a source of 242 mg. of radium. Gamma-rays from this source and X-rays at 240,000 volts, both 18 in. from the film, required an equal exposure of 1½ hrs. at 4.6 in. of steel. At 6 in. of steel, however, the exposure for gamma-rays is 6 hrs., while that for X-rays is about 5 days.

Mochel ("A.S.T.M. Symposium on Radiography and X-ray Diffraction") compares the two methods as follows. Cost of film, developing, film holders, etc., does not differ greatly. Gamma-ray practice offers marked advantages in the way of operating expense, as the operator may go about other work during exposure periods.

As to cost of plant, one may consider the matter from many standpoints. Probably over 200 mg. of radium could be purchased for the price of a 300-kv. X-ray unit. Both will do excellent work in their respective fields of application. If "life" be the desideratum, radium will reach its half-life in about 1,600 years.

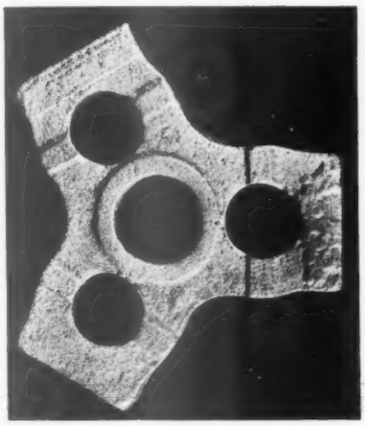

FIG. 7.—MANGANESE STEEL HAMMER.

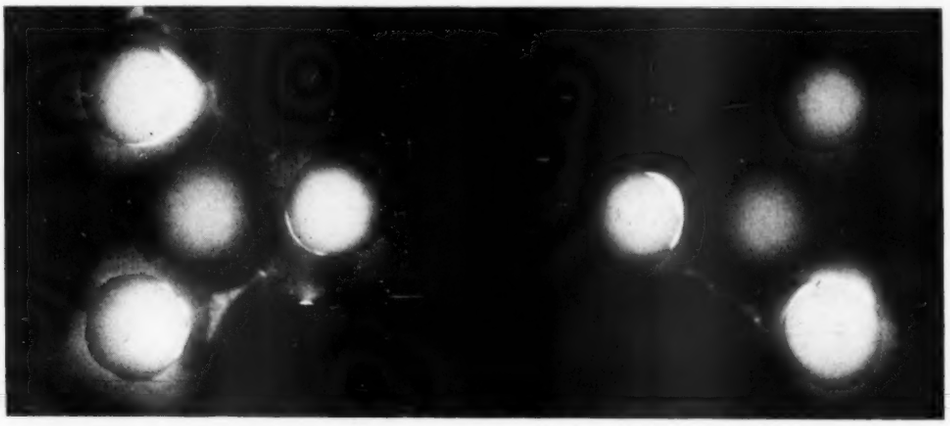

FIG. 8.—RADIOGRAPHS OF THE CASTING SHOWN IN FIG. 7.

FIG. 9.—NI-CR-MO CAST-STEEL ELBOW.

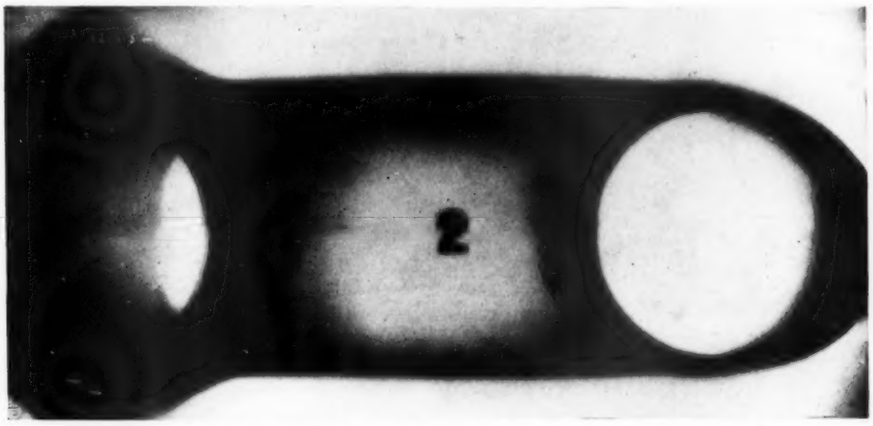

FIG. 10.—RADIOGRAPH OF STEEL ELBOW SHOWN IN FIG. 9.

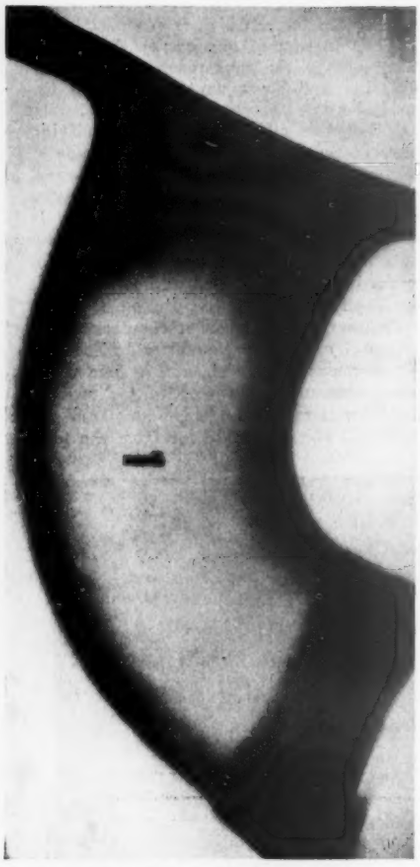

FIG. 11.—RADIOGRAPH OF ELBOW ON SIDE.

FIG. 12.—RADIOGRAPH OF MANGANESE CAST-STEEL CUTTER BLADE.

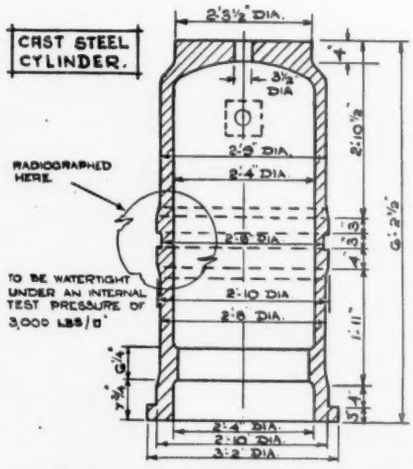

FIG. 13.—CAST-STEEL CYLINDER.

FIG. 14.—RADIOGRAPH OF CENTRAL PORTION OF CYLINDER SHOWN IN FIG. 13.

FIG. 15.—MANGANESE STEEL CUTTER.

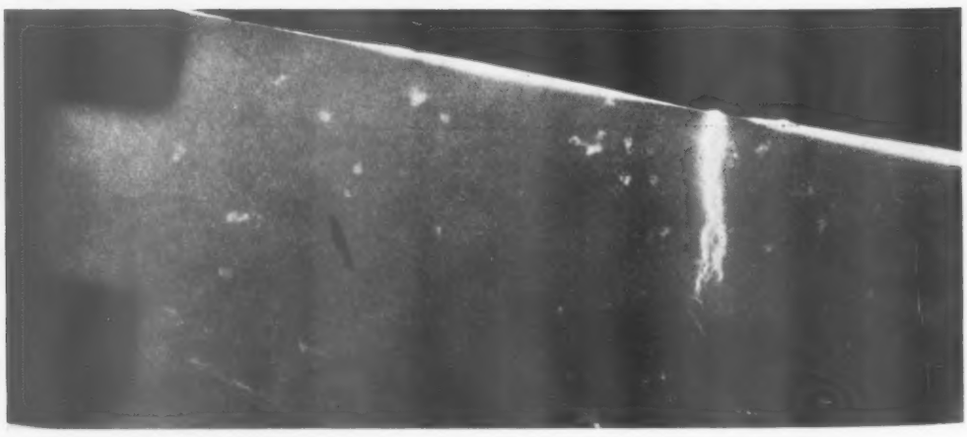

FIG. 18.—RADIOGRAPH OF BOX-SHAPED STEEL CASTING SHOWING A HOT TEAR.

FIG. 16.—RADIOGRAPH OF CUTTER SHOWN IN FIG. 15.

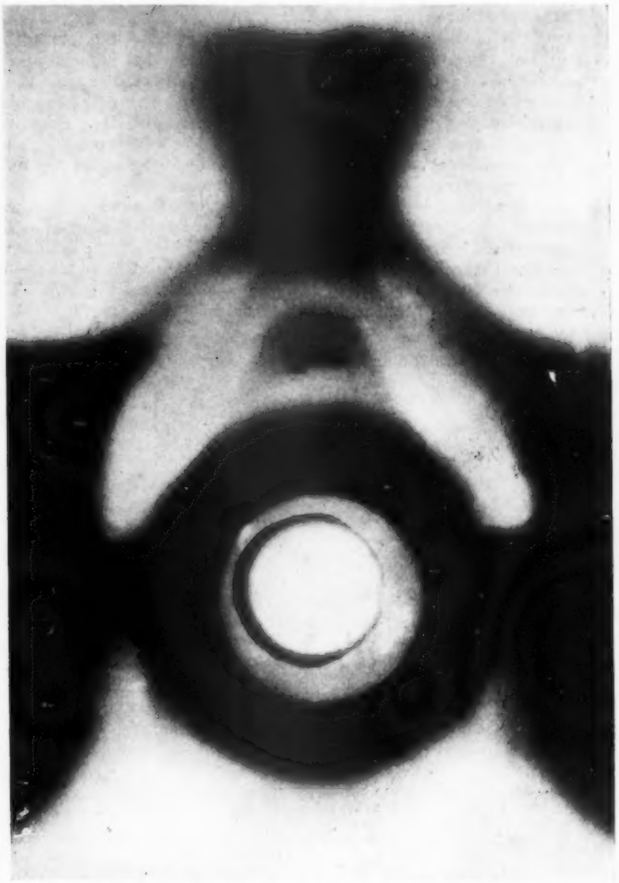

FIG. 17.—RADIOGRAPH OF A CROSSHEAD CASTING.

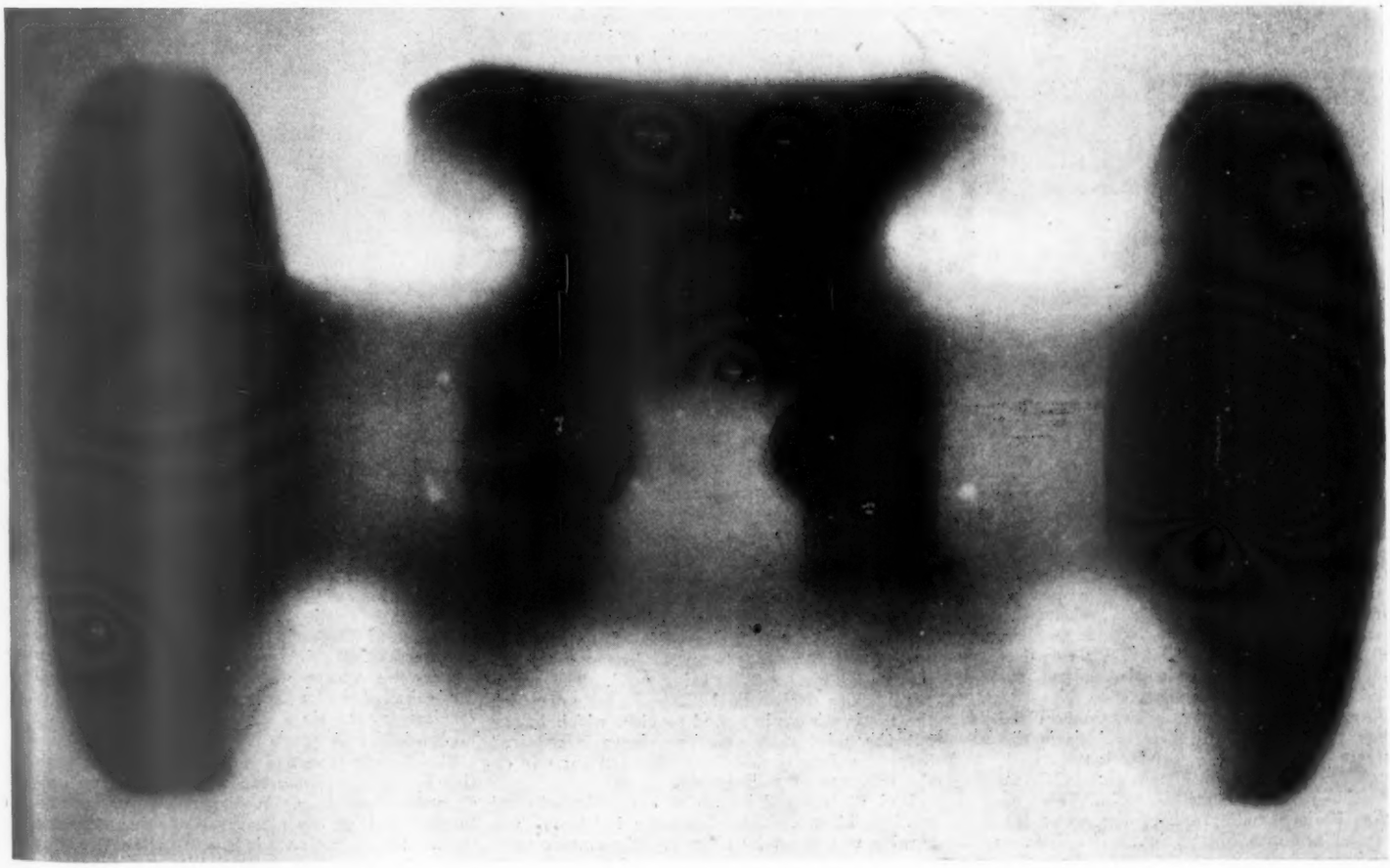

FIG. 19.—RADIOGRAPH OF A VALVE BODY WHICH IS SHOWN TO BE A GOOD CASTING.

Radium requires no maintenance and occupies very little space, while X-ray units of large size are not usually portable. Radium can be quickly set up and used, requiring no power from without; nor is it affected by line failures. It requires no switches, wiring, ventilation or water. It can be worked continuously, day and night, over week-ends, with no personnel required to operate it. Also one radium source can be arranged to yield gammagraphs of a number of objects at once, placed around it, under it and over it.

Although such comparison seems very cut and dried, the laurels rest with neither method, for they are both supreme in their own field. Industry has need for both, and the exploitation of gamma-rays should be encouraged equally alongside X-rays.

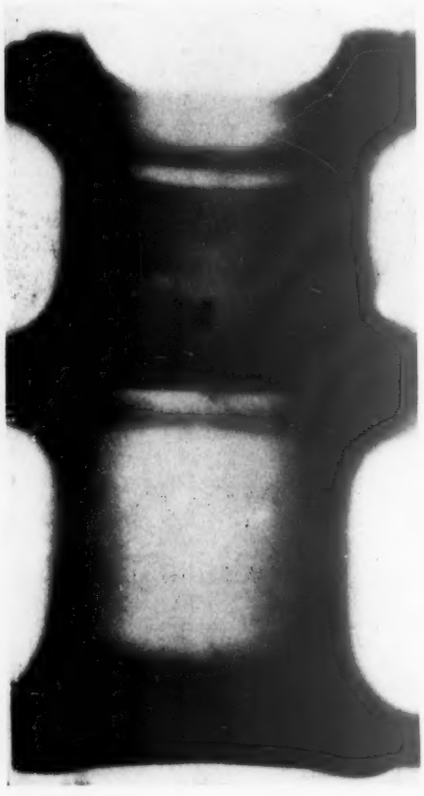

FIG. 20.—RADIOGRAPH OF A REAR SPRING BRACKET.

Examples

The following illustrations show a few examples of work encountered during the use of radiography at Penistone. They have been chosen as illustrations of the various types of jobs for which radiography is suited. The radiographs have suffered somewhat in the process of being converted into blocks, but they are still quite good enough for the purpose. Thus Fig. 7 shows an austenitic 14 per cent. manganese cast-steel hammer, weighing 6 lb. Fig. 8 is a radiograph of the hammer shown in Fig. 7, wherein the distance of target to casting was 22 in., exposure 20 secs., and voltage 160 kv. It reveals cracks or hot tears, drawing in the central portions, and drawing near the riser.

An elbow in nickel-chromium-molybdenum cast steel is shown in Fig. 9. This is the pilot casting made before production started, and was radiographed both as shown and lying on its side as a check on the technique of casting. Fig. 10 is a radiograph of the elbow taken as in the previous illustration. The distance was 20 in., the voltage 235 kv., and filters 1.5 mm. lead and 0.76 mm. copper.

Fig. 11 is a radiograph of the same elbow, but with the casting lying on its side. After inspection of the casting and of the two radiographs, the slight marking shown distributed over the pictures was found to be due to surface blemishes, and the casting pronounced sound. A casting which is to be radiographed must be finished very well on the surface, for surface irregularities show up on the exograph in a way which is quite out of proportion with internal defects.

A radiograph of an austenitic 14 per cent. manganese cast steel cutter blade is shown in Fig. 12. The exposure was 35 seconds and the voltage 115 kv. The illustration shows a generally bad casting, porosity, and a crack on the top arm. The porosity was cured by redisposition of the runner, and the crack, which arose from severe quenching, was remedied by changing the mix slightly, thus enabling the heat-treatment to be modified so that less drastic quenching was required.

The various figures given of exposure time, distance, and voltage are interesting in that they bring out the flexibility of the apparatus. The same set-up may be used for thin and thick sections alike. In making a radiograph there are four main variables, namely the tube current, the tube voltage, the distance between the tube and the film, and the time of exposure. The tube current is usually maintained at a constant figure for all radiographs, and, as far as possible, the tube-to-film distance is standardised. This leaves the tube voltage and time of exposure as variables. In general, the lower the voltage the greater the contrast, but a certain minimum voltage is necessary for complete penetration. Experience tells what voltage to use for any thickness, and the exposure is varied to meet it. Too low a voltage or too short an exposure gives a very thin negative, while too high a voltage or too long an exposure gives a very black negative. The mean, using as low a voltage as possible commensurate with reasonable exposure time, yields radiographs of good contrast and density, wherein the internal structure of a casting is adequately revealed.

Fig. 13 shows a sketch of a cast steel cylinder. The cylinder was found to be leaking in service. The casting was returned to the makers and X-rayed in the leaking portions to determine location and nature of the defects.

A radiograph of the central portion of this cylinder, shown in Fig. 14, was obtained under the following conditions: Thickness, about 2 in.; distance, 20 in.; voltage, 265 kv., and exposure, 8 mins.

The outer portions of the casting were too thick to give any appreciable record at the voltage used, so that only the central, grooved portion has shown on the radiograph. This portion shows shrinkage cavities due to unsuitable casting and feeding methods.

A photograph of an austenitic 14 per cent. manganese cast steel cutter is reproduced in Fig. 15, and Fig. 16 is a radiograph of it procured under the following conditions: Metal thickness, ½ in.; distance, 22 in.; voltage, 130 kv., and exposure, 20 secs.

The dark spots show porosity, and the lighter spots show surface irregularities. The trouble in this cutter was remedied by redistribution of the runners and risers and in general casting practice.

Fig. 17 shows a radiograph of a crosshead casting. The voltage was 265 kv. and the exposure 5 mins., a filter being used. The radiograph shows defects in the bore, in spite of which the casting is giving good service, which brings out the point that some experience is required before castings should be condemned entirely on the evidence of radiographs.

Fig. 18 is a radiograph of a box-shaped steel casting, 14 mm. thick, showing a hot tear. The trouble was cured by changing the runner positions to allow free contraction, and by casting at a lower temperature.

Fig. 19 in a similar way delineates a valve body showing a good casting, procured under the following conditions:—Voltage, 235 kv. and exposure, 5 mins., filters being used.

A radiograph of a rear spring bracket is shown in Fig. 20. The details in this case are:—Thickness, ½ in.; voltage, 265 kv., and exposure, 5 mins.

Shrinkage cavities by the bosses being indicated, the casting was made sound by chilling the bosses and changing the position of the runner.

Fig. 21 shows a radiograph of a small valve body taken under the following conditions:—Distance, 14 in.; voltage, 175 kv.; exposure, 30 secs.; copper filter used.

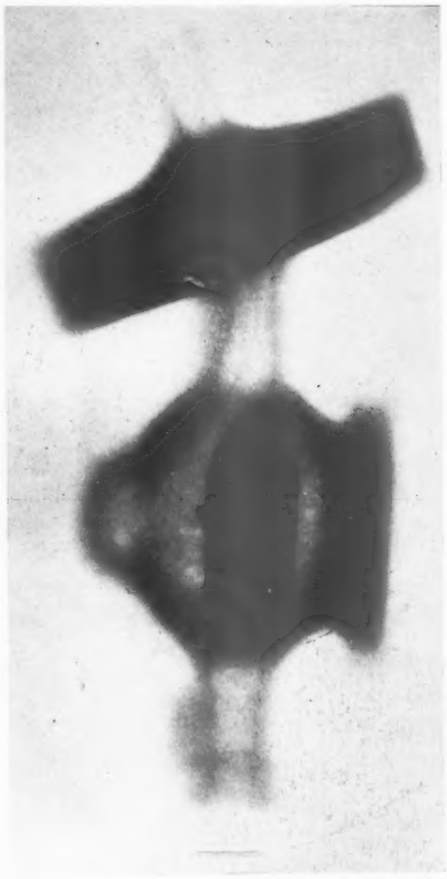

FIG. 21.—RADIOGRAPH OF VALVE BODY.

Radiographs of a nozzle box found to be leaking in service, showing an unmelted densener, are reproduced in Fig. 22. In this case the larger size of cassette was used and half the plate covered with lead sheet while the other half was exposed.

Conclusion

It is often possible and practicable to apply this non-destructive method of testing as an aid to routine inspection or to the post-mortem investigation of failures. It is, however, a short-sighted policy to confine radiography to the field of inspection. Uncertainty as to the soundness of the interior of a casting has been a very big factor in making designers search for substitutes for cast metals in welding, forging or stamping. There is a quite justified mistrust of castings.

The foundryman can only win back his position by developing methods which tend to produce sound castings. Radiography may be used to this end as an aid in developing foundry techniques, as not only is it non-destructive, but it is usually cheaper and quicker than cutting up a casting.

The idea of foundry research seems to be gathering a greater following every day, and shop experiments of a general, fundamental nature, not necessarily connected with any particular production job, are becoming a necessity. Radiography may be used as a supplementary method of investigation on this work.

Another field which will assuredly repay inquiry is the use of model castings as pilots. Successful attempts have already been made whereby the running and risering of a casting have been studied on model castings, much smaller than the actual job. The same principle is used in the study of aerodynamics, the design of ships' hulls, and numerous other fields where the behaviour of the full-scale process may be judged and often accurately calculated from work on a small-scale model.

The examination of deep cracks and flaws by tomography and planigraphy is now being developed in the Research Department, Woolwich. By the use of this method it is possible to obtain the shadowgraph of one thin layer of a casting on the film, while the remainder is blurred or completely absent. The tube and the film are connected together by a link mechanism, so that, during the exposure, the tube is moved from left to right above the casting, while the film is moved from right to left under the casting. Both tube and film move on an imaginary pivot located in the casting at the point chosen for investigation. Since the relation of the pivot to both the target and the film is constant, the shadowgraph of the point will show up clearly on the film, while points above and below will be blurred.

In conclusion, the author would like to give his thanks to the directors of David Brown & Sons (Huddersfield), Limited, for their permission to publish this Paper, and to H. Walton, M.Sc., of the Research and Development Department of the Penistone Works, who assembled all the data for the Paper, and E. Firth, head of the laboratories at Penistone Works, who is responsible for the various radiographs.

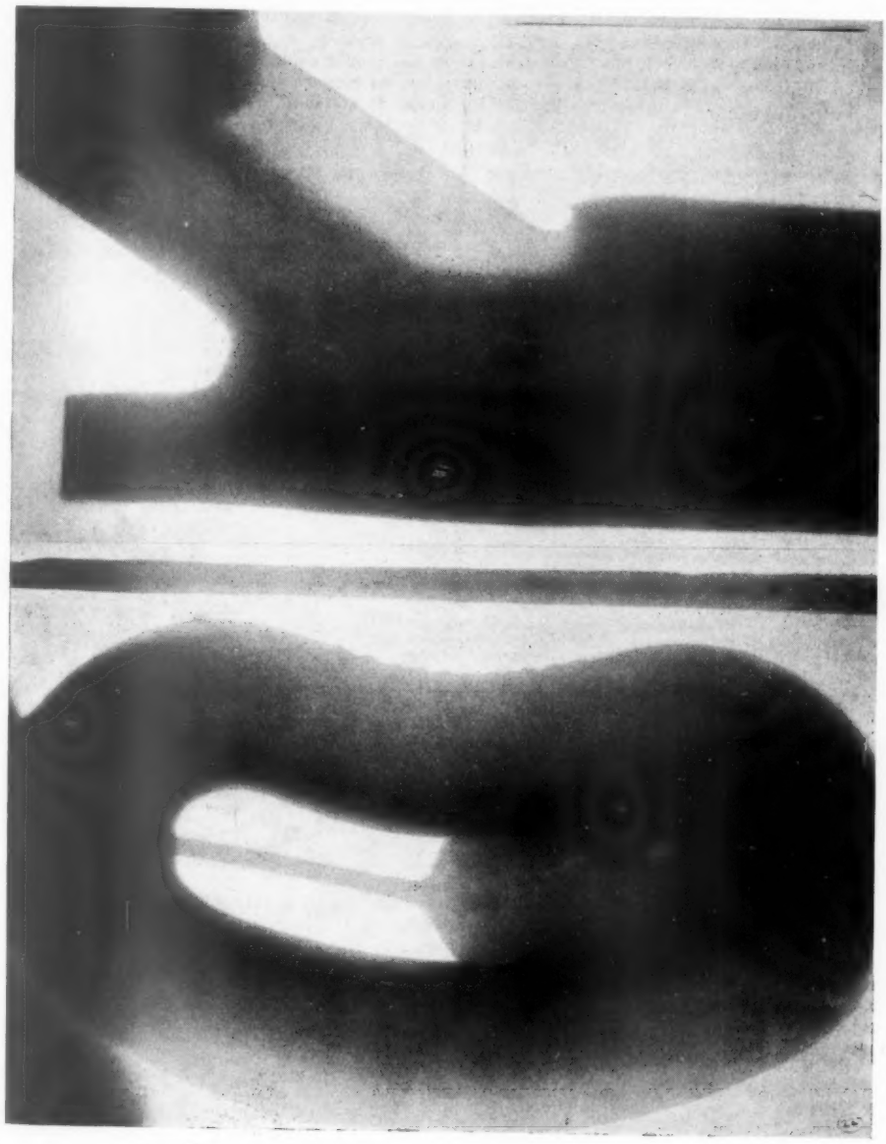

FIG. 22.—RADIOGRAPHS OF NOZZLE BOX, SHOWING CAUSE OF LEAKAGE TO BE AN UNMELTED DENSENER.

Foundry Company Changes Hands

The firm of engineers, brass and iron founders, Aldam & Company, of Misterton, Notts, has, it is announced, been purchased by Mr. W. T. Wales, of Gainsborough. Established in 1892, the firm was conducted for many years by Mr. J. W. Aldam, who still retains an interest in the business. A new company has been formed, styled Aldam (Misterton), Limited.

Iron and Steel Institute

AUTUMN MEETING IN CARDIFF

The Autumn Meeting of the Iron and Steel Institute will be held in Cardiff on September 12 to 15, by the kind invitation of the iron and steel industries of South Wales. A reception committee has been formed in order to carry out the arrangements for the meeting, with Mr. J. S. Hollins, as chairman, Mr. D. J. Young, hon. treasurer, and Mr. W. F. Cartwright, hon. secretary.

The provisional arrangements are as follow:—

TUESDAY, SEPTEMBER 12.

The Secretary's office will be open from 3 p.m. at the South Wales Institute of Engineers, Park Place, Cardiff, for the registration of members, and for the distribution of programmes, badges, tickets, etc.

The Right Worshipful the Lord Mayor of Cardiff will open the meeting and extend a welcome to members at the South Wales Institute of Engineers at 7 p.m., after which there will be a technical session for the presentation and discussion of Papers.

WEDNESDAY, SEPTEMBER 13.

The Secretary's office will be open at 9 a.m. at the South Wales Institute of Engineers, Park Place, Cardiff, for the registration of members, and for the distribution of programmes, badges, tickets, etc. In the morning a visit will be paid to the East Moors Works, Cardiff, of the Guest Keen Baldwins Iron & Steel Company, Limited (members and ladies), after which there will be luncheon at the City Hall, by invitation of Guest, Keen & Nettlefolds, Limited. In the afternoon there will be a visit to the works of Guest, Keen & Nettlefolds, Limited, at Cardiff. In the evening a civic reception (followed by dancing) will be held at the City Hall, Cardiff, by invitation of the Right Worshipful the Lord Mayor.

THURSDAY, SEPTEMBER 14.

Thursday will be devoted to an all-day excursion to the Ebbw Vale Works of Richard Thomas & Company, Limited. Luncheon will be served at the works by invitation of Richard Thomas & Company, Limited. In the evening there will be a dinner at the City Hall, Cardiff, by invitation of the Guest Keen Baldwins Iron & Steel Company, Limited, when Dowlais Male Voice Choir will be in attendance.

FRIDAY, SEPTEMBER 15.

The morning will be occupied by an excursion to Newport, when one of the following works will be visited:—(*a*) John Lysaght, Limited; (*b*) Newport & South Wales Tube Company, Limited; (*c*) Whitehead Iron & Steel Company, Limited. Members will be entertained to luncheon at Newport by invitation of the Newport works. In the afternoon there will be a garden party at Cardiff Castle by invitation of the Most Hon. the Marquess of Bute, K.T. The evening will be left free.

All transport to works and on excursions will be by motor buses and no private cars will be allowed.

An attractive programme has also been prepared for ladies attending the meeting.

Distribution of Metallurgical Output in France

According to the Report of the Commission permanente des valeurs de douane for 1938, 41 per cent. of French pig-iron output was made in the Meurthe-et-Moselle area, 37 per cent. in the Moselle, 13 per cent. in the Nord, 5 per cent. in the Ouest, and 4 per cent. in the Centre and Midi regions. About 81 per cent. of basic steel was made in the Est; the distribution of Martin steel was 30 per cent. in the Nord, 27 per cent. in the Meurthe-et-Moselle, 22 per cent. in the Moselle, and 12 per cent in the Centre and Ouest.

Position of the Development of Centrifugal Casting in Germany

By W. A. GEISLER

(*Concluded from page* 32.)

Centrifugal Casting of Non-Ferrous Metals

The successful introduction of the centrifugal casting process in the case of cast-iron pipes also led non-ferrous foundries to make exhaustive experiments with this process. It was very soon found that quite considerable improvements in quality were possible, as compared with sand casting. These improvements are all due to the exceptional refinement of structure which the material undergoes through the twofold effect of the centrifugal force and the rapid, uniform cooling (Figs. 9, 10 and 11). This refinement of structure, in the first place, results in a considerable increase in the tensile strength and hardness.

Table II gives a summary of the physical properties of various red brass and bronze alloys, the mean values and the minimum values for centrifugally cast alloys being compared with the DIN (German Industrial Standard) values for sand cast alloys. In order to secure the best possible mechanical properties in the case of non-ferrous metals, usually cold or slightly preheated or even water-cooled metal moulds are employed. The rapid cooling in the centrifugal mould has a substantial influence on the attainment of a fine-grained and compact structure which is consequently resistant to corrosion and wear.

In the case of non-ferrous metals, centrifugal casting in sand moulds results in a much coarser grain and hence a deterioration in the physical properties. In the centrifugal casting of non-ferrous metals, maintenance of the correct speed is of great importance. If the mould is rotating too slowly, the inner surface of hollow cylinders is very rough and the entire cross-section of the casting is often permeated by blow-holes. At the optimum speed, however, the inner surface is smooth and less machining is subsequently required.

In the case of alloys having components of a widely different character, as soon as the molten material has assumed the speed of the mould, the specifically heavier components are forced outwardly against the wall of the mould on account of their greater centrifugal force, and thus the specifically lighter components are situated more in the inner parts. Such liquation becomes more pronounced, the greater the solidification range of an alloy, the more dissimilar are its components, the lower the rate of cooling, the greater the centrifugal pressure and the thicker the wall of the castings. By regulating these working conditions, *i.e.*, therefore by maintaining suitable speeds of the moulds, a suitable pouring temperature, regulating the cooling and so forth, however, liquation can in most cases be kept within such limits that it does not cause any trouble.

NON-FERROUS PIPES

Osnabrücker Kupfer- und Drahtwerk Process

In Germany, pipes of considerable size are made of non-ferrous metals. The works application of the centrifugal casting process for the manufacture of non-ferrous pipes was first carried out in Germany in 1926/27 by the Cologne firm of Ostermann & Flüs. The chief reason for this was the severer demands made on the mechanical properties of non-ferrous metal alloys in connection with the increased section thickness." The centrifugal process employed was very simple. The mould was mounted horizontally and there was no movement between the pouring spout and mould during the casting operation. The process was later taken over and developed by the Osnabrücker Kupfer- und Drahtwerk.

In Osnabrück, at first only alloys of special brasses were cast centrifugally. These were brass alloys containing 54 to 62 per cent. copper, and sometimes more. In addition to zinc, such alloys also contain mainly nickel, manganese, aluminium and iron, which together may amount to about 7 per cent. The mechanical properties attained with this alloy by centrifugal casting clearly showed the fundamental superiority of this process over sand casting. Table III shows an increase in tensile strength of about 20 per cent., and an increase in elongation of about 25 to 50 per cent., as compared with normal sand casting. In addition to this increase in the tensile strength, the perfect homogeneity and freedom from porosity are of particular and even greater importance.

Subsequent development of the centrifugal casting process was effected by the same firm in connection with red brass and bronze alloys. Centrifugal castings of these alloys exhibited over the greater part of their periphery crater-like cavities rendering the pipes useless. The cause of this phenomenon was quite apparent to the foundryman, as it was well known that "splashing" of the walls of the mould in ordinary metal mould casting resulted in similar phenomena caused by evolution of gas on solidification.

Of the various possible methods of avoiding these defects, two were mainly found to be feasible after lengthy experiments. In the first place, contact of the metal with the material of the mould could be prevented by a lining of sand, as employed in America. This, however, would result in a deterioration of the physical properties on account of the changed conditions of solidification. The second method finally adopted consisted in selecting the material of the mould in such a manner that the dangerous absorption of gas upon the entry of the metal, *i.e.*, upon splashing, did not occur. Such a mould material was found in copper and various copper alloys.

For economic reasons, however, it was out of the question to make the moulds of solid copper

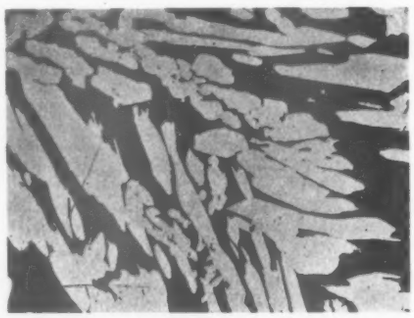

FIG. 9A.—SAND CASTING. × 100.

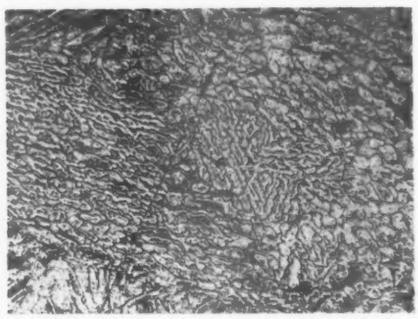

FIG. 9B.—CENTRIFUGAL CASTING. × 100.
60/40 BRASS.

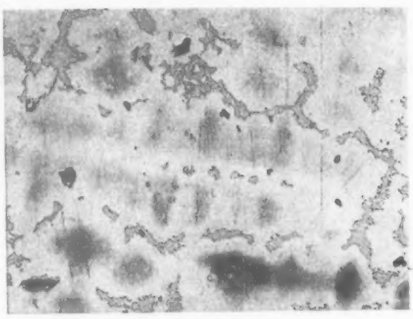

FIG. 10A.—SAND CASTING. × 100.

FIG. 10B.—CENTRIFUGAL CASTING. × 100.
86/10/4 RED BRASS.

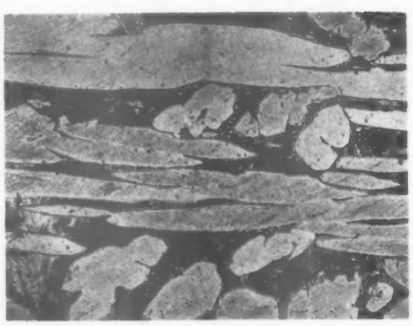

FIG. 11A.—SAND CASTING. × 100

FIG. 11B.—CENTRIFUGAL CASTING. × 100.
90/10 ALUMINIUM BRONZE.

or copper alloys, since all dimensions up to 1,500 mm. diameter and 10 metres in length occur. An appropriate solution to the problem was found by lining the actual cast-iron mould with relatively thin copper sheets of 1 to 3 mm. in thickness.[33] For this purpose, the copper sheets are bent approximately to the requisite diameter and pushed into the mould. Close application of the copper sheets to the wall of the mould is effected automatically by means of the centrifugal force as soon as the mould has been brought to the high speed usual for centrifugal casting. In this way, it is possible to cast centrifugally all the metal alloys used to-day for various purposes, such as bronze, red brass, nickel-copper, Monel metal, etc., in a satisfactory manner, quite free from porosity, because all contact of the molten metal with the cast-iron or steel mould is avoided.

TABLE II.—*Properties of Various Non-ferrous Metals Centrifugally Cast compared with Standard Specification Requirements for Sand Castings.*[35]

Material according to D.I.N. 1705.	Centrifugal casting. Mean values. Tensile strength. Tons per sq. in.	Elongation. Per cent.	Brinell hardness. Kg. per sq. mm.	Centrifugal casting. Minimum values. Tensile strength. Tons per sq. in.	Elongation. Per cent.	Brinell hardness. Kg. per sq. mm.	D.I.N. requirements for sand castings. Tensile strength. Tons per sq. in.	Elongation. Per cent.	Brinell hardness. Kg. per sq. mm.
Rg 5 ..	16.5	13	80	15.9	12	75	10.5	10	60
Rg 9 ..	17.1	9	90	15.9	7	85	12.7	12	60
Rg 10 ..	19.0	9	95	17.1	8	90	12.7	10	65
GBz 10 ..	19.6	12	90	17.8	8	80	12.7	15	60
GBz 14 ..	20.3	3	115	17.8	2	105	12.7	3	90
GBz 20 ..	21.6	0	220	19.0	0	190	10.5	0	180
BlBz 10 ..	19.0	12	80	17.8	8	75	11.4	15	70

Figs. 12 and 13 show some of the centrifugally-cast pipes made by the Osnabrücker Kupferwerk. The finished castings weigh up to 6 tons, and for such castings melts of about 10 tons, that is to say, considerable weights, are centrifugally cast. From the point of view of size, the centrifugal castings of the Osnabrücker Kupferwerk are not surpassed in any country. The pipes shown in Fig. 12 are 10,050 mm. long with an external diameter of 500 mm. and a wall thickness of 25 mm. The centrifugal casting with cast-on flange shown in Fig. 13 has a length of 3,620 mm., an external diameter of 1,500 mm. and an internal diameter of 1,460 mm.

In the centrifugal casting of such tubular bodies, there is formed on the inner surface of the material a fissured and strongly oxidised zone which, even though relatively thin, has generally to be removed mechanically before the pipe can be used or treated further. The following is the explanation of the formation of this inner zone:—

When the molten metal is poured into the mould, the air present in the mould is strongly heated, so that it escapes at a considerable velocity, while cold air continuously flows in, cooling the metal from the interior. The metal solidified on the inner surface cannot, of course, participate wholly in the reduction in volume which occurs upon the complete cooling of the casting. The consequence is that the metal cracks. The entrance of cooler air naturally exercises a strong oxidising action on the material, particularly at the fissured places. The new small fissures which are continually being formed are immediately oxidised.

The Osnabrücker Kupferwerk eliminates these harmful effects[34] by providing a curtain of hot gas in front of the aperture of the mould. This curtain of hot gas prevents the escape of hot air from the mould and corresponding entrance of cold air into the mould, and displaces all the oxygen of the air, so that, even if gases are drawn into the mould, only neutral or reducing gases come into contact with the metal, and on account of their high temperature, these gases do not produce any undesirable chilling. The pipes produced in this way have a perfectly smooth, metallically clean inner surface without appreciable oxidation.

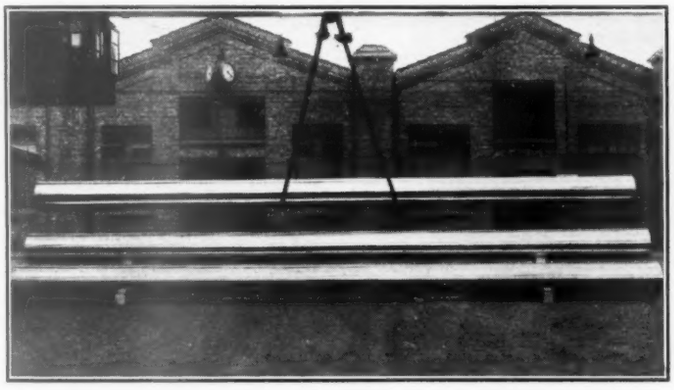

FIG. 12.—CENTRIFUGALLY-CAST PIPES BY THE OSNABRÜCKER KUPFERWERK, 10,050 MM. LONG, AND 25 MM. WALL THICKNESS.

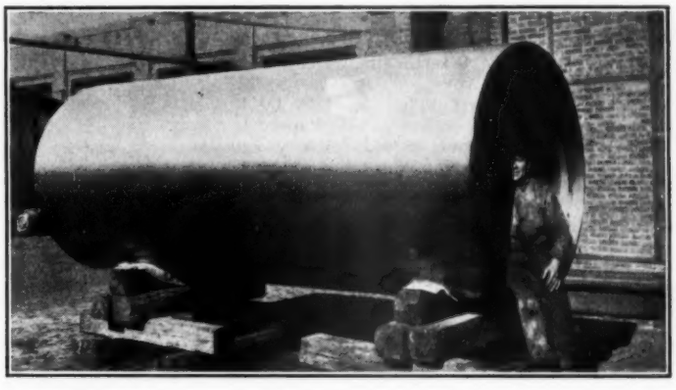

FIG. 13.—CENTRIFUGAL CASTING WITH CAST-ON FLANGE (OSNABRÜCKER KUPFERWERK), 3,620 MM. LONG, AND 1,500 MM. EXTERNAL DIAMETER.

The Schwietzke Process

The firm of I.G. Schwietzke, of Düsseldorf, adopted the manufacture of centrifugal castings early in 1930,[35] the Briede-de Lavaud system being employed. For ensuring uniformly good properties in the centrifugally-cast products, it is considered that uniform cooling conditions are essential, and intensely water-cooled moulds are therefore employed. The casting process corresponds to the casting of sewer pipes. The casting machine is movable by means of a mechanical contrivance. The quantity of metal corresponding exactly to the weight of the pipe to be cast is run into the tilting ladle and from the latter it is poured through the pouring spout into the mould. At the instant the issuing metal comes into contact with the wall of the mould, the machine carrying the mould is set in movement. The stream of metal is now applied helically to the mould, being pressed uniformly against the inner surface of the latter by the centrifugal force and thus forming the pipe. Apparently, the helical application of the metal eliminates the above-mentioned difficulties connected with "splashing."

The provisional manufacturing installations of I.G. Schwietzke permit the production of pipes having external diameters of 50 to 160 mm. with internal diameters of at least 30 to 50 mm. in lengths of 1 to 1.25 metres, and pipes with external diameters 150 to 270 mm. and wall thicknesses up to 60 mm. in lengths of 3 metres. Special machines are actually provided for the centrifugal casting of worm wheels and spur wheels. In these machines, rings of up to 540 mm. external diameter and heights of up to 200 mm. can be made. The following materials are being cast successfully by the centrifugal process:—Copper, bronze, red brass, brass, special brass, nickel bronze, aluminium bronze, Monel metal, Silumin and other alloys.

In addition to tensile strength, hardness, elongation, soundness and uniformity, resistance to wear and the bearing and running properties of a material are of considerable importance in many fields of application. Centrifugal castings made in cooled moulds possess these properties to such a degree that this process must be considered as being of revolutionary significance in connection with the production of plain bearings. Wear tests carried out in the Kaiser-Wilhelm Institute in Düsseldorf showed that centrifugally cast red brass 5 has approximately three times the resistance to wear of sand-cast red brass 5.

TABLE III.—*Showing the Superior Properties of Centrifugally Cast Brass.*[32]

Special brass no.		I.	II.	III.
Tensile strength. Tons per sq. in...	Centrifugal casting ..	24.0	31.1	45.9
	Sand casting	20.3	25.6	39.0
Elongation. Per cent.	Centrifugal casting ..	40.2	29.0	13.3
	Sand casting	33.3	22.0	8.5
Brinell hardness	Centrifugal casting ..	105.0	138.0	175.0
	Sand casting	91.0	115.0	150.0

Vertical Centrifugal Casting

(For rings, plates, double-walled tubular bodies, etc.)

The firm of Hundt & Weber, of Geisweid, have made a speciality of centrifugal casting with a vertical axis of rotation and have developed their own centrifugal machines for vertical cast-

ing.[4 36] In centrifugal casting with vertical axis of rotation, the molten metal is poured directly into the rotating mould. It then ascends, being driven up by the centrifugal force. A uniformly thick pipe, however, is not formed, but the wall thickness diminishes upwardly in the form of a parabola. The inner shape of the casting is therefore formed by a paraboloid of revolution. This is steeper, the higher the peripheral speed. Calculations of the speed necessary for vertical centrifugal casting

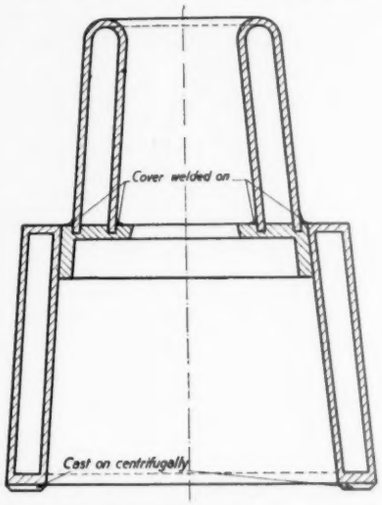

FIG. 14.—CENTRIFUGALLY-CAST TUYERE, BY HUNDT & WEBER, GEISWEID.

moulds were given as long ago as 1898 by E. Lewicki, as mentioned earlier in this Paper.[6]

In vertical centrifugal casting, gravity acts against the ascent of the metal, and as compared with horizontal centrifugal casting, a higher centrifugal pressure and hence also a higher speed are necessary. Vertical centrifugal casting is therefore generally employed for castings of small height relatively to their diameter, for instance the rims of worm-wheels, spur wheels and bevel wheels.

An excellent application of vertical centrifugal casting is the process developed by the firm of Hundt & Weber for the production of double-walled tubular bodies,[37] more particularly blast-furnace tuyeres (Fig. 14). These are conical tubular bodies with double, closed side walls, through which cooling water is passed when in use for protecting the tuyeres against the attack of the hot blast-furnace gases. Formerly, these highly-stressed elements were made by forging from electrolytic copper. Production is much quicker to-day in heights of up to 1,000 mm. and individual weights of up to 300 kilograms. In addition, it is stated that the mechanical properties attained in centrifugal casting are substantially better than those attained by forging.

In recent years, an extraordinarily large number of patents have been granted for centrifugal casting, and to discuss them would be to go far beyond the scope of this Paper. Reference may be made, however, to a further process of the firm of Hundt & Weber[38] for the production of hollow cylinders having internal and external flanges, as well as bodies of any shape by centrifugal casting. The process, which, of course, also concerns the centrifugal casting of iron and steel, although up to the present it has only been used for casting non-ferrous metals, in the production of hollow cylinders having internal flanges, employs a core for forming the inner surface of the casting (Fig. 15).

This method of centrifugal casting, as well as centrifugal casting in mould boxes, where the inner surfaces of the castings are not formed by centrifugal force alone and the speeds employed are low, cannot be regarded as true centrifugal casting. Cooling of the castings progressively from the outside to the interior only occurs in the case of true centrifugal casting. In the case of profiled centrifugal castings, where cooling must occur in different directions, the resulting shrinkage, cavity formation and porosity make their appearance. The real purpose of centrifugal casting, namely, the absolute guarantee of soundness and freedom from cavities is, however, not attained in profiled centrifugal casting. The centrifugal casting of billets or bars (Fig. 16) in sand moulds with central pouring gate may produce good, sound castings, but this can also be done in simple metal moulds which also ensure a better yield. If complicated moulds with cores are used, it is to be expected that both the mould and also the cores will be damaged and the consequence will be much waste.

The production of blanks in the form of plates or rings of non-ferrous metals by centrifugal casting is a considerable field of application for this process. For example, metal wire plates are made in dimensions of about 450 mm. diameter and 20 to 40 mm. thickness (G. Schmadt & Company, Letmathe). The metal is poured slowly into the mould and is suddenly chilled, producing a fine-grained structure. The plate is annealed and formed into wires.[39] Besides these thick plates or slabs, thin plates are also cast with a thickness of only 8 mm. and a diameter of 700 mm.[40] The casting of these thin plates eliminates annealing and rolling work.

It is nowadays possible, without difficulty, to cast centrifugally rings, for example, for worm rings, weighing 4 to 5 tons, satisfactorily in aluminium bronze. To cast such a large worm ring in sand, it would be necessary to employ

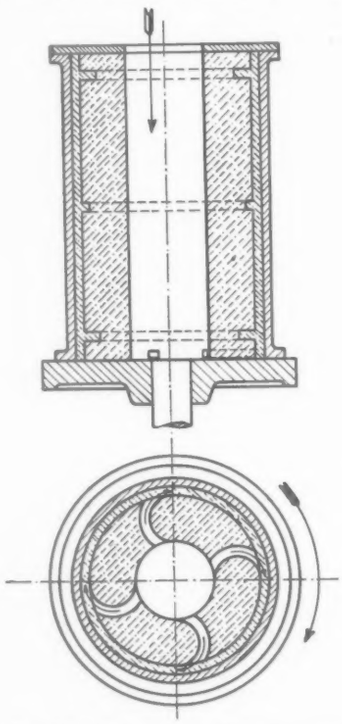

FIG. 15.—PROCESS FOR MANUFACTURE OF HOLLOW CYLINDERS WITH INNER FLANGES. GERMAN PATENT 578,928.

a metal charge of about 10 tons and to eliminate shrinkage effects by means of extensive risers. The centrifugally cast ring is satisfactorily sound and, in addition, has a high tensile strength.[41]

Casting and Lining of Bearings

Bronzes and red brasses centrifugally cast in tubular form in cooled moulds form excellent bearing metals. An example of the advantageous application of liquation phenomena is obtained in the centrifugal casting of bearing metal on a lead basis. The hard, specifically lighter zinc crystals are forced on to the inner surface, and as supporting elements are embedded in the lead. The bearing properties of a bearing made in such a way, and hence its life, are considerably increased. In practice, such bearings have been cast centrifugally in weights of up to 500 kilograms and have given excellent service.[42]

The lining of bearings by centrifugal casting has nowadays become customary in most factories employing the mass production of bearings, such as, for example, in motor-car factories. Fundamentally, the processes resemble the centrifugal

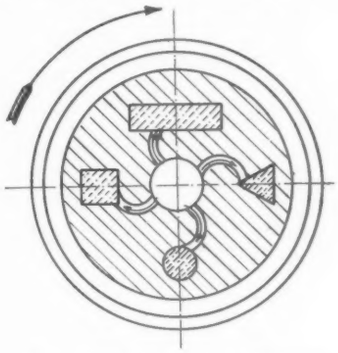

FIG. 16.—CENTRIFUGAL CASTING OF BILLETS OR BARS, ACCORDING TO GERMAN PATENT 578,928.

casting processes described. Numerous machines have been constructed for this purpose and they are continually being improved with the object of rendering automatic the operations of heating the bearings, cleaning the surfaces, applying a flux and pouring in the metal to the exclusion of all oxidising influences, so that the lining of the bearings can proceed on the travelling band.

REFERENCES.

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33 German Patent 542092, Osnabrücker Kupfer- u. Drahtwerk, July 30, 1930.
34 German Patent 592456, Osnabrücker Kupfer- und Drahtwerk, Jan. 25, 1934.
35 V.D.I.-Mitteilungen des Niederrheinischen Bezirksvereins (1933), No. 7.
36 German Patent 561210, Hundt & Weber G.m.b.H., Sept. 5, 1931.
37 German Patent 585362, Hundt & Weber G.m.b.H., August 2, 1929.
38 German Patent 578928, Hundt & Weber G.m.b.H., March 23, 1931.
39 "Der Schleuderguss," Dr.-Ing. A. Väth, V.D.I.-Verlag, Berlin, 1933.
40 German Patent 489383, Walter Bremicker, Dec. 24, 1929 German Patent 546340, Walter Bremicker, Feb. 25, 1932.
41 "Giesserei," 25 (1938), pp. 395–401.
42 "Giesserei," 22 (1935), pp. 428–434.

Iron and Steel Production in June

The British Iron and Steel Federation reports that there were 114 furnaces in blast in the United Kingdom at the end of June, compared with 113 furnaces at the end of May, one furnace having resumed operations during the month. The production of pig-iron in June at 715,700 tons included 111,200 tons of hematite, 476,500 tons of basic, 98,600 tons of foundry, and 15,400 tons of forge pig-iron. In May last the output was 692,100 tons, and in June, 1938, 541,500 tons.

The production of pig-iron in the first six months of 1939 totalled 3,636,800 tons, as against 4,005,400 tons in the first six months of 1938.

Steel operations last month were more than maintained in comparison with May, although the actual output declined from 1,218,100 tons to 1,175,600 tons. June represented 26 working days as compared with 27 in May, and the daily rate of output increased. There were 356 steel furnaces in operation at the end of June compared with 335 at the end of May.

The Week's News in Brief

Trade Talk

CONSTRUCTION WORK on the new magnesium factory in Cardiff for International Alloys, Limited, is expected to begin shortly.

ABELSON & COMPANY (ENGINEERS), LIMITED, have removed from 55, Pershore Street to new premises at Coventry Road, Sheldon, Birmingham, 26.

THE BRITISH INCORRODIBLE METAL COMPANY, LIMITED, is being wound up voluntarily. Mr. R. G. Leach, 11, Ironmonger Lane, London, is the liquidator.

TWO NEW WORKSHOPS are being erected at the Netherton works of R. Y. Pickering, Limited. Operations on the extension will continue over the holiday period.

THE GREEK MINISTRY have ordered boilers and machinery for two destroyers from Yarrow & Company, Limited, of Glasgow. The contract, which is worth £419,600, is in two sections, and machinery is to be delivered to the Greek Government in December, 1941, and March, 1942.

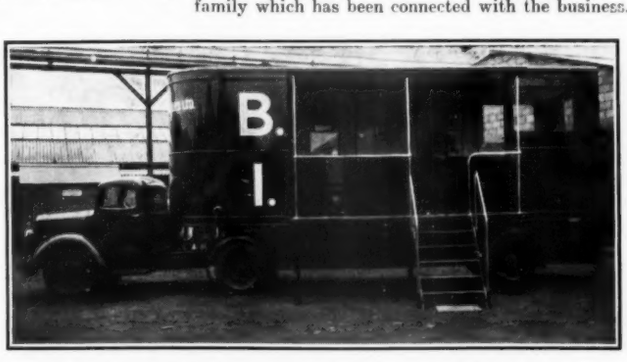
TERMS HAVE been agreed upon between Barrow Hematite Steel Company, Limited, of Barrow-in-Furness, and Colvilles, Limited, Glasgow, by which, as part of an exchange of products manufactured by each company, the Barrow company will cease to operate its heavy and merchant mills for a period of ten years from January 1, 1940. The Barrow company will retain and continue to operate its mines, blast-furnaces, and hoop and bar mills.

THE ANNUAL MEETING of the British Foundry School will take place at the Education Offices, Margaret Street, Birmingham, at 2.30 p.m., on Tuesday, July 25, and all interested are invited to attend. The fourth session of the School closes on July 26, and the next session will open on September 19. Applications for admission can now be received, and forms can be obtained from the Secretary of the School, at the Central Technical College, Suffolk Street, Birmingham, from whom any further information can be obtained.

AT THE annual staff dinner of C. & W. Walker, Limited, ironfounders, of Donnington, held on Saturday last, Mr. R. J. Milbourne (chairman and managing director) handed long-service medals to six members of the staff with over 50 years' service each. They were :—Mr. F. C. Franks (formerly works manager), 57 years, and Mr. H. Lowe (formerly store keeper), 56 years—both quite recently retired; Mr. B. Bott, 54 years; Mr. H. Bott, 52 years; Mr. J. W. Morgan, 50 years, and Mr. E. J. Wood, 50 years. Mr. G. F. H. Beard, general manager, revealed that Mr. Milbourne was also entitled to a medal, as he had served the firm for 51 years.

THE ADMIRALTY have decided to entrust the construction of two "L" class destroyers of the 1939 programme to each of the following firms:—Scotts' Shipbuilding & Engineering Company, Limited, Greenock; Parsons Marine Steam Turbine Company, Limited, Wallsend-on-Tyne (hulls by Vickers-Armstrongs, Limited, Newcastle-upon-Tyne); Alex. Stephen & Sons, Limited, Linthouse, Govan; and the Fairfield Shipbuilding & Engineering Company, Limited, Govan. In addition, orders for two minesweepers have been placed with each of the following firms: Blyth Dry Docks & Shipbuilding Company, Limited, Blyth, with machinery by White's Marine Engineering Company, Limited, and William Denny & Bros., Limited, Dumbarton, with machinery by Harland & Wolff, Limited.

BRITISH INSULATED CABLES, LIMITED, of Prescot, Lancs, have equipped a special demonstration van to give working demonstrations of B.I. magnetic moulding machines and resistance welders. The plant, which comprises a squeeze strip moulding machine (type S.S. 324), a butt welder (type 75), and a spot welder (type 94), is arranged to work from an a.c. supply at or about 400 volts. The welders are connected direct across the 400 volts circuit, and a rectifier is installed for use with the moulding machine. Trailing cables for connecting to an outside source of supply are carried on the van. The vehicle itself is of the six-wheeled articulated type, and is specially constructed to carry the concentrated loads of the machines. One of the sides of the body can quickly be opened out, thus converting the van in a few minutes into an attractive showroom.



BRITISH INSULATED CABLES' DEMONSTRATION VAN.

Personal

SIR CHARLES CRAVEN, managing director of Vickers-Armstrongs, Limited, has been re-elected for the fourth year in succession President of the Tyneside Industrial Development Board.

MR. REGINALD W. THORNTON, chairman of the Glacier Metal Company, Limited, has resigned from the board owing to ill-health. Mr. W. B. D. Brown, joint managing director, has been appointed chairman in his place. Mr. J. C. Gaukroger has been appointed a director of the company.

RETIRING AFTER 39 years' service with Noble & Lund, Limited, machine-tool makers and ironfounders, of Felling, Gateshead-on-Tyne, Mr. R. H. Greensitt was presented last Friday with gifts from directors, staff and workmen. Mr. Greensitt, who is 71 years of age, has been foundry manager for 37 years. Mr. Percy Noble, chairman of directors, presented him with an inscribed silver salver on behalf of the board. Mr. T. H. Taylor (foreman patternmaker), on behalf of the staff, handed over a Westminster chiming clock, and from the workmen of Mr. Greensitt's department a pair of prism binoculars were presented by Mr. Joseph Quinn.

MR. DONALD M. ROBERTSON, who has been appointed light-castings foundry manager of Newton, Chambers & Company, Limited, Thorncliffe Ironworks, Sheffield, received his early training at the works of Blackadder Bros., Falkirk. War service intervened, and then he was at Coventry for a time. He returned to Watson Gow & Company, Etna Ironworks, Falkirk, as assistant works manager. After the amalgamation of the Etna Ironworks and Grangemouth Ironworks, Mr. Robertson continued with the firm for another three years, following which he became assistant foundry manager of Thos. Allan & Sons, Bonlea Foundries, Thornaby-on-Tees, and was there for six years, until taking up his present appointment with Newton Chambers as light-castings manager.

Wills

CROMPTON, C. E., chairman of Cochran & Company Annan, Limited, Newbie Engineering Works, Annan £32,305

MIDDLETON, R. S., chairman of S. P. Austin & Son, Limited, shipbuilders, and deputy-chairman of Richardsons, Westgarth & Company, Limited ... £123,811

Obituary

MR. R. L. SCOTT, chairman of Scott's Shipbuilding & Engineering Company, Limited, Greenock, who died suddenly at his home at Greenock recently, was 69 years of age, and was the last surviving member of the sixth generation of the family which has been connected with the business.

Iron and Steel Tube and Pipe Merger

STEWARTS AND LLOYDS AND STANTON IRONWORKS

As a result of negotiations which have been proceeding between the boards of Stewarts and Lloyds, Limited, and the Stanton Ironworks Company, Limited, it is announced that the basis of terms for an amalgamation of interests has now been provisionally settled.

It is proposed that the merger should be in the form of an offer by Stewarts and Lloyds to the stockholders of Stanton Ironworks to acquire all the issued stock of Stanton on the following exchange: For every £1 unit of 6 per cent. preference stock of Stanton one £1 unit of 6 per cent. first preference stock of Stewarts and Lloyds; for every £1 unit of ordinary stock of Stanton one £1 unit of deferred stock of Stewarts and Lloyds plus 12s. 6d., to be satisfied partly in 5 per cent. third preference stock units of Stewarts and Lloyds, taken at a value of 22s. per £1 unit, and partly in cash. The arrangements will also include provision for the interchange of directors, etc.

The proposals are subject to the stockholders of Stewarts and Lloyds passing the necessary resolutions for creating the stock required for the exchange, and also to the offer being accepted by the holders of not less than 90 per cent. of each class of the issued stock of Stanton or such smaller proportion as Stewarts and Lloyds shall agree to accept. Further communications advising the stockholders of both companies of the full terms will be sent out to them after the details have been arranged.

Leading Makers

Stewarts and Lloyds, Limited, are leading makers of iron and steel tubes, and the Stanton Ironworks Company, Limited, hold a similar position in respect to cast-iron pipes. The merger should be of mutual advantage to the two companies. Well-equipped technically, they manufacture products which are to some extent in competition.

Stewarts and Lloyds, Limited, have an authorised capital of £10,370,275, of which £7,880,991 has been issued. In 1930 the company entered into a scheme of closer co-operation with Tube Investments, Limited, and in 1932 undertook a programme of development of its iron ore and blast-furnace properties at Corby, Northamptonshire, and the erection of new steel and tube works adjacent to the blast furnaces, operating the basic Bessemer process. Trading profits for 1938 were a record at £2,649,791.

The Stanton Ironworks Company, Limited, owns ironworks, blast furnaces, foundries, brickworks, collieries, etc., in Derbyshire and Nottinghamshire. The issued capital is £2,878,916, and for the year to March 31 last the trading profit was £507,074.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Duncan Campbell (Ironfounders), Limited, Albion Foundry, Preston Street, Middleton.—Capital, £500. Directors: H. and J. Campbell.

Shaw & M'Innes, Limited.—Capital, £40,000. Ironfounders, engineers, etc. Subscriber: A. D. MacInnes Shaw, Firhill Ironworks, Glasgow, and J. S. Brown.

Engineering & Lighting Equipment Company, Limited, Sphere Works, St. Albans, Herts.—Capital, £200,000. Gas, water, electrical, mechanical, and general engineers, etc. Directors: S. A. Marples, W. Bird, W. Jewitt, and G. J. Wells.

Contracts Open

Cairo, August 2.—Cast-iron pipes, etc., for the Tanzim Department of the Egyptian Ministry of Public Works. (D.O.T. reference: T. 24,136/39.)

Johannesburg, August 31.—Approximately 191 tons of steelwork and three tons of bolts, rivets, etc., for the South African Railways and Harbours Administration. (D.O.T. reference: T. 24,756/39.)

Swellendam, August 14.—Cold-starting crude-oil engine and alternator; control panel with instruments, etc., for the Municipality, Swellendam, Cape Province. (D.O.T. reference: T. 24,748/39.)

Raw Material Markets

Although the demand for foundry pig-iron shows little expansion from week to week, the iron and steel industry generally continues to be very active. Orders in connection with national defence projects are substantial and will remain so for a long time to come, while a slight lessening in the international tension has resulted in some improvement in the amount of civil work placed.

Pig-Iron

MIDDLESBROUGH.—Apart from the absence of business for local needs, there is no feature in the export market to warrant special mention, while deliveries to Scotland have not been made for some time past. Producers continue to curtail their outputs to very small proportions and their stocks are low, but no difficulty is met in meeting current orders. Business in hematite is quite satisfactory, but some disappointment is felt at the tonnage involved in recent transactions since lower prices came into operation. Nevertheless, deliveries are being made much more freely, and makers' stocks are being steadily reduced. In addition, consumers in other parts of the country are placing orders for fairly substantial tonnages.

LANCASHIRE.—The uncertainty which existed with regard to future prices of foundry iron has been dispelled by the announcement that producers are not making any changes in quotations for the time being. This has not resulted, however, in any material increase in business, which remains very quiet. Consumers are still not placing orders for heavy supplies, and current trade is restricted to small parcels for delivery in the near future. Certain light-castings and jobbing foundries have a little more work on hand, but their position continues to be unsatisfactory; textile and machine-tool and heavy electrical engineering concerns are all fairly well employed, and consumption of iron is moderately good. The call for supplies of hematite is much improved, and the outlook for this section is quite promising.

MIDLANDS.—Light-castings foundries, which are the chief consumers of high-phosphorus iron, are still in need of additional business, and their iron requirements are not sufficient to justify their taking up heavy tonnages. At the same time, some of them have recently bought ahead, owing to the uncertainty of the international situation, which, they fear, may result in supplies of iron becoming difficult to secure in the future. Deliveries under contracts of low-phosphorus iron are being taken up at a good rate; there is not a lot of new business in this material, as consumers covered their requirements some time ago. Heavy tonnages of hematite are changing hands and business in this section is likely to be active for some time to come, as users allowed their stocks to become very low before the reduced prices came into force on July 1. The heavy foundries which use hematite are well employed, and have a fair amount of Government work on hand.

SCOTLAND.—The Glasgow Fair holidays have restricted any new business that might have been offering in this area and the market is very quiet. Foundries in the Falkirk area have restarted work following their holidays, but there is still little business emanating from this quarter. Most of the steelworks are idle, but holidays are being made to affect production as little as possible. Hematite mixed numbers are quoted at 115s. 6d., and basic iron at 92s. 6d., both delivered f.o.t. steelworks and less 5s. rebate.

Coke

Business continues to be done quite freely in foundry coke and many buyers have satisfied their needs over some months to come. For delivery in Birmingham and district, best Durham foundry coke and Welsh coke are quoted at a minimum of 50s. 6d., this price ruling until the end of the year, when the position will be reviewed.

Steel

The demand for all descriptions of structural steel continues to be exceptionally strong and works are hard pressed to meet all orders. Contracts extend in many cases for months ahead and delivery specifications have recently increased. A certain amount of delay is being experienced, as makers' order-books are so well filled that congestion has resulted, but there is as yet no actual shortage. Sheet makers, too, are fully engaged on existing commitments, which extend over some time ahead, and certain grades are now difficult to procure unless the purchaser is willing to await the convenience of the maker as far as deliveries are concerned. Light sections of steel are well booked for early delivery.

Scrap

Steel scrap is still in heavy demand, and although many consumers report that supplies are now coming through with less delay, all available material is eagerly taken up. Recent imports from the United States have undoubtedly relieved the position, but it is hoped that additional supplies will shortly arrive from that source. Prices are, of course, controlled very strictly and users are willing to buy ahead at present quotations, but most sellers are unwilling to commit themselves too far forward. A steady demand exists for most grades of iron scrap, but supplies, generally speaking, are fully ample to meet consumers' requirements.

Metals

Copper.—Despite the fact that the June statistics for this metal were satisfactory, the tone in the market of late has been rather quiet; the uncertainty of the future precludes much forward business being done and speculators have recently been conspicuous by their absence. Prices reacted favourably to the monthly statistics, but the daily turnovers have been disappointing. World stocks of refined copper during June decreased by 7,228 tons to 513,670 tons. The apparent world consumption was 180,000 tons, an increase of 8,000 tons, while the world output by mines and smelters totalled 162,000 tons, a decrease of 3,000 tons. The world production of refined copper was 173,000 tons, against 170,000 tons in May.

The demand for copper in the United States continues to be on a good scale, but business has returned to more normal proportions. In view of the extremely heavy buying that has been witnessed recently quieter conditions are expected to prevail for a considerable time to come; sales of domestic copper during the current month are already more than sufficient for three months' consumption. There is little likelihood of any rise in the recently increased domestic quotation.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £42 16s. 3d. to £42 17s. 6d.; Friday, £42 16s. 3d. to £42 17s. 6d.; Monday, £42 12s. 6d. to £42 13s. 9d.; Tuesday, £43 1s. 3d. to £43 2s. 6d.; Wednesday, £42 17s. 6d. to £42 18s. 9d.

Three Months.—Thursday, £43 2s. 6d. to £43 3s. 9d.; Friday, £43 2s. 6d. to £43 3s. 9d.; Monday, £43 to £43 1s. 3d.; Tuesday, £43 7s. 6d. to £43 8s. 9d.; Wednesday, £43 3s. 9d. to £43 5s.

Tin.—Conditions were very easy in this market until Tuesday, when the turnover was about 700 tons in excess of the recent average. American business, too, has improved, and consumers are taking up better tonnages. In a recent interview at Singapore, Sir Lewis Fermor, the metallurgist and geologist, who has been making investigations into Malaya's mining industry, stated that his report would be the longest ever made and would contain much important information for the industry.

Official quotations were as follow :—

Cash.—Thursday, £229 17s. 6d. to £230; Friday, £229 17s. 6d. to £230; Monday, £229 17s. 6d. to £230; Tuesday, £229 17s. 6d. to £230; Wednesday, £229 17s. 6d. to £230.

Three Months.—Thursday, £224 15s. to £224 17s. 6d.; Friday, £225 to £225 5s.; Monday, £225 2s. 6d. to £225 5s.; Tuesday, £225 2s. 6d. to £225 5s.; Wednesday, £225 2s. 6d. to £225 5s.

Spelter.—The undertone of this market is remarkably firm in view of the fact that current business is disappointing. The galvanisers are in the market for heavy tonnages, but other working-up industries generally are poorly situated for work. The present steady position of the metal is likely to be maintained so long as the galvanisers are able to work to capacity, but the outlook, on the whole, gives rise for some concern.

Daily market prices :—

Ordinary.—Thursday, £14 1s. 3d.; Friday, £14 2s. 6d.; Monday, £14 3s. 9d.; Tuesday, £14 6s. 3d.; Wednesday, £14 2s. 6d.

Lead.—Consuming works connected with the rearmament programme are accounting for a steady consumption of this metal, but most other users are not taking up supplies as well as could be expected. On the whole, however, the market is steady and the future is viewed fairly optimistically. The American Bureau of Metal Statistics reports that world production of lead in May was 169,200 tons, compared with 161,600 tons in the previous month.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 12s. 6d.; Friday, £14 13s. 9d.; Monday, £14 15s.; Tuesday, £14 18s. 9d.; Wednesday, £14 16s. 3d.

Scrap.—A much brighter tone has been in evidence this week, and the demand for non-ferrous metal scrap has been considerably increased. In addition to an improved home demand, there has been a better export inquiry, Germany particularly being in the market for substantial tonnages.

Approximate selling prices for old metal are firmer, as follow:—New aluminium cuttings, £72; rolled, £62; cast, £31 to £35; foil, £80. Copper, £39 to £44; braziery, £37. Brass (clean), £23 to £26. Zinc, £9. Lead, £13 5s. Gunmetal, £39.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

505,292. SADLER, A. L. (Pittsburgh Lectromelt Furnace Corporation). Method of and means for sintering or fritting refractory linings by means of an electric arc.

505,412. HERAEUS-VACUUMSCHMELZE AKT.-GES. Coreless induction furnaces.

505,711. DEUTSCHE EDELSTAHLWERKE AKT.-GES. Permanent magnets.

505,790. PRIEST, C. F. Vertical re-heating furnaces.

505,954-5. SANKEY & SONS, LIMITED, J., and ALBERTINI, A. Means for use in casting metals.

505,978. MYERS, A. C. Solution for use in the heat treatment of steel.

506,110. JOHNSTON, I. C. Slag pocket and method of construction.

506,377. DORTMUND-HOERDER HUTTEN-VEREIN AKT.-GES. Passage vessels for separating pig-iron and slag.

506,403. ELLIS, L. S. E. (United States Steel Corporation). Method of manufacturing low-phosphorus steel.

506,432. POWELL, A. R., and JOHNSON, MATTHEY & COMPANY, LIMITED. Manufacture and production of fine metal and alloy powders.

506,486. NAAMLOOZE VENNOOTSCHAP WALLRAMIT HANDEL MAATSCHAPPIJ. Machines for the manufacture of shaped pieces of hard metal by heat treatment.

506,622. BRASSERT & COMPANY, LIMITED, H. A. (Brassert & Co., H. A.). Tuyères for shaft furnaces.

506,745. SADLER, A. L. (Hayes, C. I.). Furnaces for the heat treatment of metals.

West Coast Blast-furnacemen's Wages

A slight drop in the wages of blast-furnacemen is reported as a result of a reduction in the selling price of West Coast hematite Bessemer mixed numbers for the quarter ended June 30. The ascertained selling price was 106s. 9.07d., a reduction of 2.52d. compared with the previous price. The sliding-scale percentage will be 70 from the commencement of the second full pay in July, a reduction of one-quarter per cent.